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Two Serious Accidents. THE two recent accidents at the Grosvenor Gallery lighting station in London, causing, as they did, the shutting down of the electric lights in a large and important district, were so serious in their results as to be worth more than a momentary notice. Twice within a month has that station been disabled, and in each case the difficulty was due to causes that should have been averted. The first fire was the direct result of a high tension arc and a very badly frightened workman. A 5,000 volt arc is, to be sure, an object well calculated to strike terror into any one not familiar with its venomous appearance and threatening roar; nevertheless, it certainly appears as though there should have been some one within reach who could retain presence of mind enough to have averted the catastrophe which followed. The second accident, produced by blowing out a bank of transformers, was much less serious, but still very annoying. Full details of it have not yet reached us, but an accident of that kind is one which is preventable, if proper cut-outs are employed. One of the objectionable features of a long-distance lighting supply like that in London is the danger of general crippling of the service by an accident at a single point. To fall into the vernacular, it is putting too many eggs in one basket. The arrangement certainly possesses certain great advantages, but the risks incurred point to the necessity of extraordinary precautions in the way of duplicate apparatus and safety appliances.

A Singular Freak of Lightning. ON another page we note the details of a singular occurrence that both points a very practical moral and suggests matters of theoretical interest. The accident referred to was the striking of three electric cars by lightning and the burning out of a field coil in each car. These three cars were descending a grade and the current was not being employed. The other motors on the line were in motion and escaped injury. Each of the three damaged motors received an injury of almost precisely the same kind. In the Sprague system one of the field coils is customarily charged, even when the current is cut off, and the lightning entering the motor jumped from this coil to the magnet core. In each case where the motors were in operation their powerful self-induction choked the discharge which would otherwise have occurred, so that no damage whatever was done. It is a capital illustration of the effect of a coil of high impedance in checking sudden and oscillatory electrical discharges. At the same time it points to the desirability of taking advantage of this fact in the construction of lightning arresters. First and last considerable damage has been done to electric street railways and apparatus, dynamos and motors by the lightning discharges to which the long overhead lines in electrical railways are particularly exposed. The remedy taken by the superintendent of the road where this particular accident occurred was a very rational one, and it is safe to predict that if his line is struck again he will not be treated to a repetition of the former damage.

Proposed Subway Management. AT a recent meeting of the Subway Board a certain specious proposition was brought in by the company that now assumes the dilatory construction of the official superheated subways, suggesting that the low tension part of its work be turned over to another company of unmentioned organization. It was said, however, that various telephone and telegraph companies are concerned in the new enterprise. It is altogether probable that such a transfer of business would lead to desirable results on the general principle that any change would be for the better, but before the authorization of anything of this kind it would be desirable to know what are the relations between the proposed company and the present one. The subway situation in this city is anything but satisfactory and the electric lighting companies would hail with joy any rearrangement of construction that could give them relief: they are not anxious, however, to change the place and keep the pain. If removal of low tension conduit building from the hands in which it is now misplaced would insure prompt subway construction and lower rates, it would be an unquestionable advantage both to the electrical companies and to the public; if, however, it only serves to place the illuminating companies still more at the mercy of the subway ring by enabling the companies using low tension wires to build their own subways and charge themselves rates more advantageous than they are now enabled to obtain, it would be a very questionable public advantage. The high tension portion of the electrical community has rights that should be respected, even by the municipal government.

Secondary Batteries. PROF. AYRTON'S paper on the chemistry of secondary cells, published in this issue, is by all means the most important contribution to our knowledge of the action going on in accumulators that has been produced since the earliest days of the secondary battery. The exact chemical reactions that take place during the operations of charging and discharging have been the subject of much dispute, and Prof. Ayrton seems to have taken the only practical way of obtaining reliable evidence. By removing from the cell portions of the active material during different stages of charging and discharging, an approximate idea may be obtained of the chemical changes that accompany these processes. This is the method of attack adopted by Prof. Ayrton against this really difficult problem, and its results seem to show the success of this method. The regularity of increase in the percentage $Pb O_2$ during charging and its decrease during discharging is very striking. As is clearly pointed out, this is rather strong evidence that the reaction consists essentially in the conversion of the $Pb O_2$ in the positive plugs and of lead in the negative into lead sulphate during discharging and their regeneration and reversal of the action during charging. Of course this state of things is complicated by minor chemical changes, and the action is never completely reversible; a fact which accounts for the gradual deterioration that occurs. Some experiments tried on accumulators allowed to rest in a charged condition led to interesting results, for it appeared that the deterioration observed under these circumstances was largely due to action on the negative plate alone, converting the metallic lead into some oxide or salt. The negative plate under these circumstances requires some time to recuperate; a number of charges are necessary before the action which has taken place can be even partially reversed, and, consequently, the result is very much as if a portion of the negative plate had been bodily removed from the cell, so that it will appear to be discharged before the positive plate has completely done its work. Incidentally, Prof. Ayrton gives no small amount of practical information regarding the formation of storage battery plates, and his present paper is an invaluable addition to the literature of the subject.

Government Control of Telegraphs. THE article by Mr. Erastus Wiman, published on another page, is one of the most practical and convincing discussions of the postal telegraph question that we have yet had the pleasure of seeing. Mr. Wiman is, of course, widely known as a singularly shrewd, level-headed, business man, thoroughly public-spirited and wide awake to the interests of the community in which he lives. His views, therefore, have a value of their own quite distinct from the fact that he is also particularly well posted in matters electrical. The government control of the telegraph system has long had fascinations for a certain class of political economists, who, either from a belief in the theory of a strong central government, or from contamination with a rather mild and inoffensive type of socialism, desire to see introduced into American society some of the paternal regulations that have acquired a better or worse reputation in foreign lands; and, as Mr. Wiman remarks, their view of the question is taken by some business men of very good judgment who have occasion to use the telegraph very frequently, and are alive to the advantages of a cheapened telegraph service. Now, to a certain extent, it is fair to say that the government could very properly assume control over the telegraphic service of the country in the same way that it has taken the mail service into its own hands, and exercises a general, though somewhat ineffective, supervision over the railroads within its borders. In so far as the telegraph system affects the commercial interests of the various parts of the country, whose welfare and business operations are properly subject to regulation by Congress, it would appear that government control of the telegraph would be eminently proper; but government control and government ownership are two very different things. The government owns the postal service, but it does not own the railroads on which that postal service depends. Its powers, however, are sufficient to see that the mail service is properly enforced. If occasion should arise for the central government to enact regulations for the interstate service of the telegraph or to take the whole system bodily under its control, as it might in the case of proclamation of martial law, no political economist and no right thinking business man would say it was exceeding its proper authority. But, when the government undertakes to assume the functions now well performed by great corporations with important vested rights, it steps beyond the boundaries that custom has laid down as suited to republicanism. The point raised by Mr. Wiman, that there is an essential difference between the mail service and the telegraph service on account of the relatively small number of persons who use the latter, is exceedingly well taken. To be sure, it might be retorted that a large proportion of the inhabitants of this country do not use the mails frequently; but, nevertheless, it is entirely true that where one person uses the telegraph with tolerable frequency, at least 10 use the mail. So that really the assumption of the telegraph lines in addition to the postal service would be not in the direction of extension, but rather the addition of a convenience provided at the public expense for the use of a comparatively limited number of persons. The telegraph cannot be fairly seized because it is a monopoly unless the same course of reasoning would cause the government control, as Mr. Wiman suggests, of the Standard Oil Company, for instance, and other of the formidable trusts that control articles of daily use by a large majority of the people. If the postal service system were adopted and a telegraph office placed in every post office, the cost of operation would be so considerable as to be a serious item of expense without a corresponding benefit. Of course it would not be necessary to make all the 60,000 post-offices telegraph offices at once, any more than it was necessary to make them all money order offices, but there is a constant pressure brought to bear on the Post Office Department to extend these extra facilities to every cross roads where an office holder can be found, and while the money order system can be thus extended at a very slight expense, the telegraph lines would be continually stretching out to insignificant hamlets where the instruments would only accumulate dust during at least nine months in the year, and reaching across barren stretches of country where the cost of maintenance would be vastly greater than any possible receipts. And this brings us to what is really the greatest objection to the scheme which has been proposed by Postmaster-General Wanamaker, as well as by some of his predecessors. All of us are unfortunately acquainted with the unpleasant results that frequently follow a change of administration. The postal service is seriously disturbed, for our civil service laws, however beautiful in theory, usually collapse under the pressure that is brought to bear upon them, and the cry of "turn the rascals out" does its work in every post-office within the limits of the country. Even with the comparatively unskilled labor required in the small post-offices the changes produce a certain demoralization that frequently is months in passing away. Fancy the result were a corps of 60,000 telegraph operators to be turned out at every rotation of the political wheel and their places taken by ward-workers and rural wirepullers, who would not know a telegraph instrument from a sausage machine unless the latter chanced to be in operation. When the country is possessed of an ideal civil service, where promotions are for merit and discharges only for cause, there might be some reasonable probability of an economically administered and efficient telegraph service. In the present state of affairs, however, any governmental assumption of the functions now administered by great commercial organizations would simply mean additional chances for corruption and all the annoyance and expense that corruption entails upon the community. Government control can only compete with private corporations in point of efficiency and economy when it is organized with the same permanence, the same official skill, and the same earnest effort to secure the best results obtainable.

The Latest Foreign Electrical News.

(By Cable from our Regular Correspondent.)

London, Dec. 8, 1890.—During the present year no less than 76 companies and municipalities have given notice of their intention to obtain permission for installing central stations. This is a considerable decrease, however, over last year, when the number was 159.

The Metropolitan Electric Supply Corporation has purchased land for an additional station at Paddington, and has already begun work on its new building.

The Barnsley town council has entered into a contract with the English Westinghouse company for a considerable installation.

The Grosvenor Gallery Station is again in trouble. After nearly a fortnight's suspension, during which some 50,000 lights were shut down, it began operation on Nov. 26, but on Dec. 2 it was compelled to shut down again. Twenty large transformers were banked and loaded to the fullest capacity, one of them broke down, and the others followed in quick succession before anything could be done to secure relief. The damage, however, was not of any seriousness compared with the previous fire which burned out nearly all the apparatus.

Prof. Ayrton's reception to Prof. Hertz at the Langham hotel was a brilliant success. It occurred on the eve of the annual meeting of the Royal Society, when a very large number of scientific men were in London, and drew together a representative gathering of English and foreign savants.

NEW BOOKS.

A Treatise on Electro Metallurgy, by W. G. MacMillan, pp. 387, 101 Illustrations. Philadelphia, 1891. J. B. Lippincott Co., $3.50.

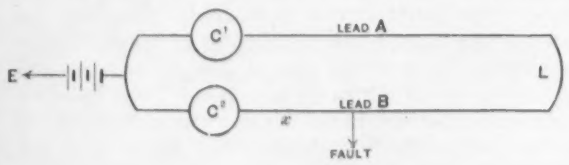
The present treatise is an attempt to systematize and explain some of the complicated operations of electro metallurgy. The intention is to present a clear and intelligible account of the practical methods of work which long experience has shown to be the best suited to metallurgical processes. There is no burdening with technical details, except in cases where these make the all-important difference between success and failure. The volume opens with a brief introductory historical chapter giving some account of the earliest work in electrotyping, and similar processes. This is followed by two important introductory chapters on the chemical theory of electro-deposition and on the sources of current employed. These chapters are brief but give a very intelligible idea both of the chemical and electrical sides of the question. Then in succession are taken up the general conditions which must be observed in all such work; the apparatus necessary to an electroplating plant, and the general manipulation of the articles, both before and after the deposition has been accomplished. Then in succession are taken up the technical details of plating, the materials most frequently used, first, of course, copper, with an especial chapter on electrotyping, and then in succession silver, gold, nickel, cobalt, iron, and some of the rarer metals. An additional chapter giving a brief account of the manipulations of alloys, electro-metallurgical processes on a large scale, and the treatment of by-products. Altogether this volume gives a great deal of explicit and useful information regarding the commercial processes of metallurgy.

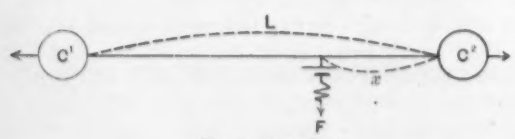
Note on Localization of Faults in Electric Light Circuits.

BY EDWARD RAYMOND BARKER.

La Lumière Electrique and other electrical journals have described M. Henri Wilbrant's test for localizing a *ground* when this occurs in one of a pair of buried leads of equal length and resistance.

Fig. 1 shows M. Wilbrant's method: Accumulator



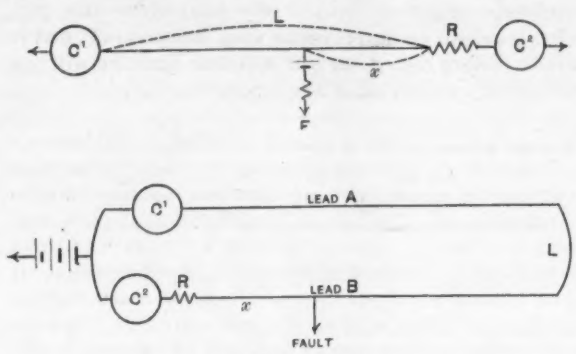


Figs. 1 and 2.

with one pole grounded, joined up through ammeters to looped leads A and B. c^1 and c^2 are deflections on respective ammeters. L = total length, or total resistance, of loop, and x = distance of fault from test station. Then $c^1 : c^2 :: x : L - x$ and $x = \frac{c^1 L}{c^1 + c^2}$ ohms or metres, according as L is in terms of ohms or metres.

The above test, in its electrical development, is an adaptation of May's formula for localizing a *ground* fault by the polarization current emanating from the fault itself. May's test is as in Fig. 2, which shows line (L) with fault at F, and grounded at both ends through similar galvanometers,* the respective deflections of which may be termed c^1 and c^2. The polarization currents from F, which flow through the two available branches, are, of course, inversely proportional to the resistances of those branches, so we have: $c^1 : c^2 :: x : L - x$, and $x = \frac{c^1 L}{c^1 + c^2}$, as above.

The following modification of this test by the writer is also applicable to M. Wilbrant's method with accumulators and ammeters. If—in May's test—F be electrically midway between the two galvanometers, c^1 will equal c^2, but if not, then, of course, the galvanometer nearest the fault will give the higher deflection. Then, if the operator whose galvanometer gives the higher deflection introduces



Figs. 3 and 4.

a resistance R sufficient to bring F electrically midway between the two galvanometers, sufficient, in other words, to make $c^1 = c^2$ (see Fig. 3), we shall have

$$c^1 : c^2 :: x + R : L - x,$$
$$\text{or } c^1 (L - x) = c^2 (R + x)$$
$$\text{and} \quad x = \frac{c^1 L - c^2 R}{c^1 + c^2};$$
$$\text{but} \quad c^1 = c^2, \text{ so } x = \frac{L - R}{2}$$

Applying the same modification to M. Wilbrant's test we have (see Fig 4)

$$c^1 : c^2 :: x + R : L - x, \qquad x = \frac{c^1 L - c^2 R}{c^1 + c^2},$$
$$\text{and if } c^1 = c^2, x = \frac{L - R}{2}.$$

Perhaps this will be found the neater method of the two, especially if the coils at R† be arranged in resistance units equivalent to metres of line: then if L = total length in metres, distance of fault $= \frac{L - R}{2}$ metres.

A Peculiar Case of Damage by Lightning to Street Car Motors.

We recently received from a correspondent a very instructive account of a singular accident from lightning, which happened the past summer, on a Sprague electric road of moderate size. The vulnerability of railway apparatus to lightning has been the cause of considerable loss to the various companies, more especially as the dynamo is subject to injury, but now and then armature and field coils on cars are burned out from the same cause. So far as the dynamo is concerned, the powerful shunt winding has a tendency to force the discharge through to the core of the armature instead of choking it as is ordinarily the case with a series-wound motor. On the particular occasion to which we are referring a severe thunderstorm occurred while the cars were out upon the line. Now the road in question has rather severe grades produced by a series of ridges over which the road passes in succession.

During the course of the storm the trolley wire was struck by lightning at a time when three of the cars were running down grade on three of the ridges before mentioned by gravity alone, the current having been cut off as usual. The other cars were in motion, several of them on heavy grades. The result of the shock was to disable the three cars that were running down grade and to leave the others quite unharmed, although from their position they were at least as much exposed as the injured ones. On subjecting the damaged cars to a careful examination it was found that the injuries received by them were almost precisely similar; in each case the "A" coil was the one damaged, and injury had occurred by the discharge from the coil to the magnet core. The cause of this selective injury of the three cars running down grade is not far to seek. In the method of field commutation employed the "A" coil, as is well known, remains always charged, even when the motor is not running. Consequently when the lightning got upon the trolley wire it was free to pass down into the motors and then broke through the insulation and jumped across to the cores. In the cars that were running this discharge was checked by the high self-induction of the magnet coils, and what small amount could pass through was free to go to earth without injury to the motor. In the cars where the current was shut off, however, there was little of this checking action and consequently the lightning jumped across to the core and went to the earth. The electrical superintendent of the road in question, who is more than usually ingenious in the matter of repairs, saw the point of the accident at once and promptly changed the connections so that the "A" coil should not be charged when the motor is not in action, but should be cut off at the switch box. Since that time the line has not been struck, so that the efficiency of this arrangement has not been tested, but the arrangement certainly lessens the likelihood of damage to the motors.

* If dissimilar galvanometers be used, knowledge of their respective *figures of merit* would still permit of comparison of deflections.

† These would be similar in general construction to those used in electric lighting and in such like heavy work.

A Large Casting for the Deptford Station.

Mr. W. S. Malcolm, assistant foundry manager at the Carron Works, has given in the London *Electrical Engineer* the following account of the casting of the first of the 23-ton castings which are to form the feet of the magnet frames of the 10,000 h. p. Ferranti dynamo for Deptford station, which feet will have to carry the whole weight of the frames, amounting to many hundred tons: "As these measure some twelve feet by ten by six feet six inches, and have each cast into their body the projecting ends of eleven magnets or blocks of soft iron three feet three inches by one foot six inches by five inches, and weighing in all about four and one-half tons, some idea may be formed of the nature of the casting. The greatest difficulty the contractors have had to overcome in the manufacture of these magnet frames has been the securing into the casting in a thoroughly fast and trustworthy manner of these large blocks of soft iron, this being absolutely necessary owing to the nature of the forces brought to bear on the magnets when the dynamos are at work. Possibly, owing to the very unusual nature of the casting, the same difficulty may not previously have presented itself to founders in any case. All the ordinary methods of casting failed to secure the desired end, and very special and novel treatment indeed has had to be resorted to before a satisfactory solution of the difficulty was found. What in ordinary circumstances would form the main core of the mold has built into its interior a light steel tank of the necessary form and dimensions to suit the magnets, and into this vessel the magnets project for about two feet of their length. You have thus at once a core fulfilling all the ordinary functions of such, and at the same time in itself a water-tight vessel surrounding the magnets. After the metal has been run into the mold and allowed to set, cold water is immediately passed through the tank or vessel, and caused to circulate round the magnets, but not in contact with the cast iron, for a period of from two to four days."

A Storage Cell for the Phonograph.

The accompanying illustration gives a general view of a new form of portable storage cell that has recently been adopted by the North American Phonograph Company for operating its instruments. It consists, as will be seen, of a single accumulator cell of large capacity, fitted in a neat portable wooden case, with a handle convenient for carrying, and tightly closed to prevent spattering of acid. A screw plug can shut the only aperture in the top of the cell, and we thus have a neatly encased and powerful battery which can be readily taken from place to place, does not endanger the furniture of the room in which it is used by liability of spattering, and does not

A Phonograph Battery.

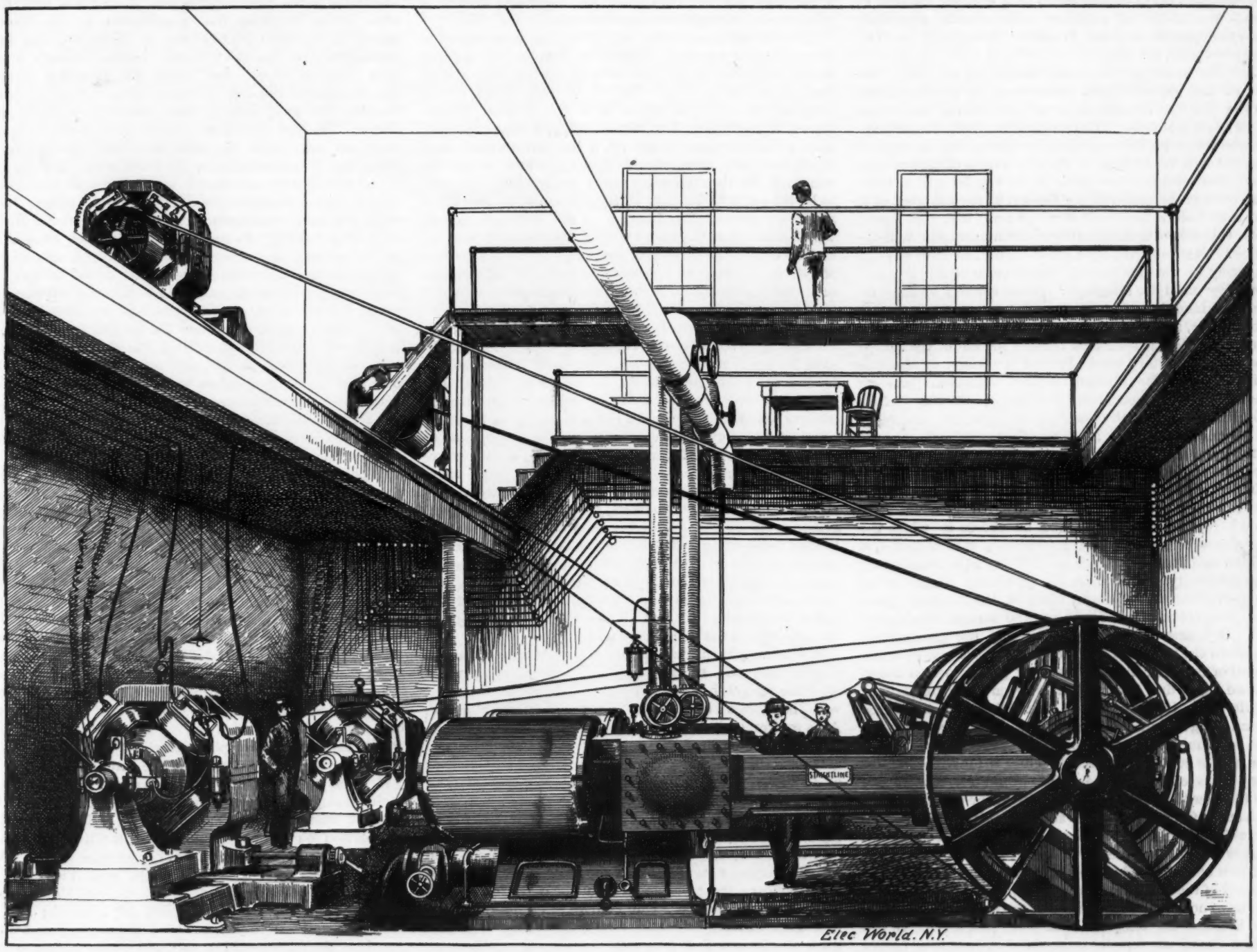
have to be placed in any special battery closet. The cell employed by the Phonograph Company for this purpose is the 17 S style of Julian battery, manufactured by the Consolidated Electric Storage Company, of New York. This accumulator has a capacity for phonograph service of about 300 ampère hours, and the elements weigh but 30 pounds, in the completed cell, about 45. The Consolidated Electric Storage Company is making these cells in their completed form for general use with the phonograph. The phonograph is now coming into considerable use for office work, and in many places where the electric light is not available, or where it is desirable to move the phonograph freely from room to room a battery is absolutely necessary. Many people have a prejudice against the primary battery

on account of the care it is apt to require, and where a single storage battery cell can replace several primary batteries and the only trouble occasioned is the necessity for recharging, it is a highly desirable addition to the phonograph outfit.

Railway Power Station at Newark, N. J.

Mr. Thos. C. Barr, the president of the Newark Passenger Railway Company, has secured the construction of a substantial and compact generating plant for the operation of the 20 cars now running on that company's lines in Newark, N. J. The plant has been in operation only about two months, as it was opened for service early in October.

The accompanying illustration shows the principal features of the station equipment. Power is furnished by two compound Straight Line engines of 250 h. p. each, furnished by Williams & Potter, the New York agents for these engines. The cylinders are 13 and 26 inches in diameter and have a stroke of 18 inches. They are built to run at a speed of 200 revolutions per minute. Steam is supplied to the engines at a pressure of 85 pounds from



GENERATING PLANT OF THE NEWARK PASSENGER RAILWAY COMPANY, AT NEWARK, N. J.

boilers built by the Iowa Iron Company through steam pipes protected with magnesia covering supplied by the Magnesia Sectional Covering Company. Each engine is belted direct to two Thomson-Houston railway generators of 100 electrical horse power each. These are of the four-pole type, are compound wound and give a normal electromotive force of 500 volts. These machines are of the same type as those used in a part of the equipment in the West End Street Railway Company's power house in Boston. Four carbon brushes are used. Two dynamos are placed upon the same floor as the engines and two are placed in a gallery above, as shown in the illustration. The switchboard is located on the wall in the gallery and is fitted with "Ajax" switches.

The present line is six miles in length, using centre pole bracket construction. The rolling stock consists of 20 cars, each 36 feet long, mounted upon two four-wheel trucks, each of which is fitted with a 20 h. p. Thomson-Houston motor, making a 40 h. p. equipment for each car. This is only the first line to be equipped by the Newark Passenger Railway Company, the company which has purchased all the Newark lines. The main power plant, which is now being planned for the system, will be about 4,000 h. p. capacity. Mr. Thos. C. Barr is president of the railroad company, and the Field Engineering Company, of this city, has constructed the lines, station, etc., described above.

Nationalizing the Telegraph.*

BY ERASTUS WIMAN.

There are tens of thousands of ardent people in the United States, many of whom, having read Edward Bellamy's enchanting dream of "Looking Backward," would favor the acquisition by the government of the telegraph system of the country. These would regard it as an important step in the direction of a universal nationalization of business interests, so that in time the millennium would be reached where there would be a literal application of the injunction to "take no thought for the morrow," for it would be left in the hands of the government to provide the wherewithal to fulfill the wants that the morrow always brings.

The government having been with some success used as the instrumentality by which the mails are distributed, and having thus filled a want of the people in supervising the means of communication by post, in letters, in publications, samples, and packages, it is natural enough that he who looks to the government to assume the place of a universal parent and provider should advocate that the means of communication next removed from the letter and the newspaper should also be transferred to its control. The next step toward a universal nationalization would logically be the assumption by the government of the railroad systems of the country, and their administration on a basis that should yield no profit, or, if any, that the profits should go to the National treasury for the good of the whole people.

The argument that because the government administers to the people in the matter of postal service it should therefore extend its service so as to include the telegraph, is not nearly so logical as that the government should assume the care of the railroads; for the railroads are the main instrumentality by which the government performs its postal service, and in order to perfect it and control it, and to carry out the principle of nationalization to the largest extent, it should own, regulate, and operate the instrumentality that carries the mails. There is, however, an earlier prospect for the assumption by the government of the telegraph than for the acquisition of the railroads—first, because it seems easier to do; second, because it imitates what is supposed to have been successfully done by the British and other governments; and third, because some really able business men are strong advocates of governmental control of the telegraph, while they would hesitate to go the length of government control of railroads.

It seems singular that on this question there should be found the dreamer of the Bellamy school—a rapidly increasing and important school, it must be admitted—side by side with some of the most practical, hard-headed business men of the period. That these two classes should agree on the nationalization of the telegraph, and agree on nothing else, is equally singular. For, after all, why should there be a movement toward inducing the government to take over the telegraph, and stop there? What is there in the facility for instantaneous communication which should particularly call for its care by governmental interference?

It seems difficult to justify a departure from the principle of non-centralization of government, and yet advocate that the government should put its hand—nay, better say its nose—into the affairs of every man who sends a telegram. It seems a step full of the deepest danger that the government of a country so vast as this, to whom of necessity are committed affairs so numerous, so vital, so essential, and the administration of which taxes the legislative and executive machinery to the utmost point of human endurance—that to this over-burdened instrumentality there should be committed the care of a business requiring, of all others, the greatest privacy, the greatest impartiality, the greatest degree of expert knowledge, the largest experience, and the highest ability. For if it is wise for the government to go into the telegraph business, it is wise for it to go into the business of every department of human activity, and to do that under existing circumstances would be, of course, to swamp the government. Even the most ardent advocate of governmental telegraphy, except among the dreamers, stops short of further business acquirement by government, and strangely draws the line at telegraphy.

The argument that the government should go into the oil business is far more forcible than that it should go into the telegraph business. Oil is almost universal in its use, and to beget its cheap and universal distribution, to make it uniformly safe, and to develop to the fullest extent the numerous ways in which it should enter into the every-day life of the people, would be a mission far more justifiable than to seek to control the telegraph business. For while probably 90 per cent. of the great mass of the people use oil for artificial light, lubricating, and other purposes, less than five per cent. of the people use the telegraph. Why should governments seek to interfere with a branch of business in which only five per cent. of the people are con-

* From *Frank Leslie's Illustrated Newspaper.*

cerned, and hesitate to take over the oil business, in which there is almost universal concern?

Some may say that the telegraph should be taken over because it has got to be a monopoly, and that its revenues, policy and control are in the hands of a few rich men. But the same argument could be used in relation to the oil business. The production, manufacture and distribution of oil is mainly in the hands of the Standard Oil Company, and more rigidly controlled, more exclusively managed, held in stronger monopolistic hands, than the telegraph system is held by the Western Union. There is only one Standard Oil Company; there are no less than forty telegraph companies. There are more shareholders among widows, administrators, and the common people generally on the Western Union stock books five times over, than are on the Standard Oil Company's stock or trust certificate book. The affairs of the Western Union are open to every man, woman, or child, who can any day buy for less than $100 a single share of its stock. Who knows anything, or ever will know anything, about the inside affairs of the Standard Oil Company except a half-dozen able gentlemen who shape its destinies? Yet the operations of the Standard Oil Company touch at a greater number of points the affairs of a greater number of the population than the operations of the Western Union ever could by any possibility do.

Let the mind of the reader reflect on the vast number of the populace that never need the telegraph, and on the few that in some shape or form are not consumers of oil or its products. The fact that less than five per cent. use the telegraph seems almost incredible; but the reader's thought will carry him to the correctness of that conclusion. For instance, how many of the vast body of laborers that work in the fields, in the forests, in the fisheries, or in the mines—how few in all this vast army use, even once a year, this means of instantaneous communication to a distance? Then stepping up a grade higher, to quite as large an army in the mechanical departments of the country, how few need the telegraph. In the country villages all over the land how few blacksmiths, carpenters, masons, shoemakers, saddlers, etc., habitually use the telegraph, while in the great industrial centres its use is the exception by the factory hands, by the workmen in the machine-shops, in the printing offices, binderies, building trades, and other mechanical avocations. Of the 10,000,000 farmers not a tenth of one per cent. use the telegraph. Of the millions of clerks in stores, offices and banks, the use of this means of communication at best is rare and fitful, except in the business of their employers.

In this wide survey of the avocations of the population how few there are that are not habitual or constant users of oil! So that if a business is to be chosen in which the experiment of governmental interference is to be tested, it is submitted that oil is much more likely to be satisfactory than electricity. In oil there is a possibility of profit for the good of the whole people, while in the telegraph there is no prospect but that of vast loss and serious dissatisfaction. Of course if it were the purpose of the government to sustain the telegraph at the expense of the many for the benefit of the few, the advocates of governmental interference might find favor. But why on earth a branch of activity requiring the highest form of ability should be chosen for governmental control, in which only five per cent. have an interest and 95 per cent. have no interest whatever, passes comprehension. Of course to make telegraphy cheap at the expense of the public would increase its use, and in order to increase its use and treat the whole country with entire fairness, the wires should be extended to every post office in the land, as is the case in Europe. If a large deficiency should stare the government in the face as resulting from an unlimited extension of telegraph facilities, the creation of the deficiency ought not to be borne by those who have no benefit for the sake of those who have.

In England the telegraph is in every post office. In the United States an equally impartial distribution of favors would make every post office a telegraph office. There are some 60,000 post offices, and if the business of telegraphy were to be even in time extended to every one of these, the entire surplus revenues of the government would be insufficient to make up the deficiency between receipts and expenditures. At present the Western Union has about 15,000 offices, which covers the country fairly well wherever there is the slightest prospect of picking up any revenue. Of these no less than 9,000 are railroad stations, the great majority of which are not post offices, and would not be telegraph offices except for the railway uses. So that there are, say, 6,000 localities which sustain a regular telegraph staff outside of the railway stations. But under the proposed nationalizing system this number must be amplified to make 60,000, with an expenditure that would be simply appalling in proportion to possible receipts. As a rule, a place with less than 1,500 inhabitants will not support a telegraph office. Take out the females and children, who rarely telegraph, the laborers, the mechanics, and those that remain among the professional and trading classes are not sufficiently numerous to sustain the expensiveness of a line of communication, the rent, fuel and taxes of offices, the salaries of operators, messengers and battery men. And yet there are not to exceed 1,500 towns in the United States with a population of over 1,500 people. The proposition, therefore, to make 60,000 telegraph offices out of 60,000 post offices is so absurd that one can hardly think that sane people have ever thought out the logical result of the proposition.

The oil business could be done at a profit by the government, and there would be some sense in undertaking to do business at a profit for a universal advantage. But why there should be attempted a business in governmental telegraphy, in which five per cent. have an interest, and tax the other 95 per cent. for their benefit, is not clear. The first cost of the oil business is quite within reason, and all that would be necessary would be to buy out the Standard Oil magnates, which could probably be done for $200,000,000. This would be a trifle compared with the amount required to take over and universally extend the telegraphs. The cost of maintenance of the oil plant would be reasonable compared with the cost of maintenance of a vast telegraph system, for there is no property in the world that sooner deteriorates than the slender poles and delicate wires spread over remote roads, through the woods, in extensions over trackless wildernesses that would be necessary in order to reach obscure post offices; while the satisfaction that follows from the practically free distribution of oil would be immensely greater than the supply of a telegraph service, cheapened and increased though it might be to an extent now undreamed of.

It is difficult to see what argument can be advanced in favor of governmental telegraphy that is not equally strong in favor of the government taking over the oil business of the country. Indeed the objections to the latter are not nearly so serious as to the former. For instance, in the height of a heated political campaign both sides would continue to use oil, if the government dealt in oil; but both sides would hardly continue to use the telegraph, for then the party out of power would not want to let the party in control of the telegraph system know all their secrets. The beauties of the political system which is based on the theory that to the victors belong the spoils would make little or no difference in the distribution of oil, but it would make a vast difference in intrusting in each community the confidential communications of which the telegraph is the necessary vehicle.

Business rivalry is bad enough, and there is, by some, thought to be considerable risk even now in transmitting over the wires messages by sound that can be interpreted by any loafer lounging outside the telegraph office. But how enormously would this be increased by the creation of sixty thousand additional office seekers among the army of telegraph operators who would become hangers-on to the tail of each party! For every four years, if the government should change in each presidential term, there would be a change in operators. For if there is any necessity for a change in postmasters, who can do no more than glance at the outside of a letter, and whose whole duty is limited to assorting and distributing sealed packages intrusted to the care of the post office, how vastly more important would it be that the party should be informed and protected by having its own operators in charge of the instruments and wires that transmitted and interpreted the messages of the entire community.

It is no argument that because the government has performed the postal service fairly well it should be intrusted with the telegraph, any more than it should be intrusted with the railroad business, or with the distribution of oil. As a matter of fact, the government has far less to do with the excellence of the postal service than is generally realized. Its whole duty in that service is the employment of facilities which private enterprise has created, and which, if it had been left to the government, would have been an appalling failure. For instance, how much does the government do toward the conveyance of the mails over the broad expanse of the continent? Without such splendid service as is afforded by the great railroad systems of the country, the government would be powerless to perform the postal service. The Pennsylvania Railroad, the New York Central, the Baltimore & Ohio, the vast network of railways that penetrate the West from Chicago, and in the South in all directions, are the means of communication which the government avails itself of in the transportation of mails, and for the promptitude and frequency of which it gets the credit.

The duty of receiving, assorting and delivering letters and papers is an extremely simple one, and it has been fairly performed; but the cause of complaint, the expensiveness of service, the danger of delay, is always where the government work comes in. The mere transmission of the mails from the great city post offices to the railroad stations is frequently the greatest cause for complaint, and whole days are lost, and mails wrecked, by wretched inefficiency in this simple duty.

The ease and simplicity of the postal duty of receipt and distribution is nothing compared with the expert knowledge, the intricacy of detail, the scientific acquaintance, and the experience needed in the telegraph service. It is true that all this could be commanded by government money and government control, but if the creation and management of a vast telegraph system, such as would be commensurate with the country and its needs, would be no better than its management of other work intrusted to it, what guarantee of satisfaction could be had? For instance, how much money has been spent in the last fifty years in the creation and maintenance of a navy, and what is there to-day to show except in the ouput of the past two years? How much has been expended on the fortifications of the land, and what is their condition? If the telegraph plant should ever reach the condition of the defenses—about New York, for instance—what would become of the business of the country? For there is no land under the sun in which the boon of instantaneous communication is so essential as in this. Distances are so great, climate so varied, the people so energetic, and the system of transportation so fully developed, that to be interfered with by government red tape, to be restricted as in England, as in Germany, by governmental officialism, would be simply torture.

The advocates for postal telegraphy are always pointing to the experience of European countries, and especially Great Britain, forgetful that the economic conditions that prevail there and here are as widely different as it is possible to conceive. For instance, in the matter of wages of operators, the rate which is received by an intelligent, expert electrician is twice that which is received by the dull, stolid, stupid post-office clerk in half the stations of England. There has been no progress whatever in electrical science in England since the government took hold of the telegraph, and there will not be in this country if the government assumes control. How aptly is this illustrated in the circumstance that, though it is true that after much haggling the government of the United States did construct the first line of telegraph, and thus demonstrate the practicability of Professor Morse's ideas, they stopped there, and when the professor offered the government the sole control of his invention for $100,000 the offer was promptly, and indeed peremptorily, declined. The then Postmaster General could see no value in what has since been the most important contribution to the means of communication the world over. Is there any prospect that other postmasters would hereafter see further ahead, and encourage inventions that would, perhaps, have as far-reaching consequences as those of Professor Morse or Professor Bell? Enterprises of this kind remain for private citizens to develop, against the discouragement of official dictum. Private citizens can afford to risk, in many cases, their entire possessions—many of them, as an actual fact, did suffer great hardship and privation in building up to its present magnitude the existing telegraph system, and it is coolly proposed that the government, which evinced such a lack of paternal instinct in the boy, should, now that the boy has grown to be a wealthy and vigorous man, assert a claim to him and his possessions.

As to the rates of telegraphy, there is always a great attraction to governmental advocates in the six-penny rate of Great Britain, forgetful that a vast deficiency is every year charged up against the Post-office Department for the indulgence in this absurd reduction to a rate less than cost of transmission. Persons who quote this rate are forgetful of the shilling rate in New York and similar States, of greater expanse than even England. England, with a surface area of 60,000 square miles, and a population of 500 people to the square mile, is held up as against the United States, with a surface area of three and a half million square miles, and a population of less than twenty to the mile. How absurd are these comparisons! Indeed, the entire telegraph system of Great Britain and Ireland, with its 30,000 miles of poles and 180,000 miles of wire, forms no basis whatever for comparison with the United States, with its 250,000 miles of poles and 770,000 miles of wire, especially as the British system, with its small and inexpensive plant, carries 54,000,000 messages annually, as against 80,000,000 in the United States.

It costs the Western Union Company 23 cents for each message handled, while to the British system the average cost is only about 13 cents. The basis for comparison on the European continent with the United States should be the surface area of the same extent. For instance, the rate between London and Vienna is 9 cents a word, while between New York and Chicago, an equal distance, the rate is 50 cents for 10 words; and so on throughout the whole areas of Europe, compared with America, the rates would be proportionately higher in the older country under governmental control than on this vast continent. Among all these great commonwealths a reasonable rate prevails in proportion to distance, which the United States government, if in control, could not reduce except at tremendous cost to the public at large.

But the disadvantages of governmental control of this most important and essential instrumentality of commerce would not only be felt every day—every hour—in the ordinary course of business, but especially in circumstances of great disaster, resulting from storms, fires, etc. The slow-moving policy of government would be painfully evident, for instance, in such a circumstance as overtook the Western Union Company at its recent fire in New York. Here, at the very centre of the throbbing and pulsating heart of the commerce of the continent, a disaster took place which in an instant seemed to paralyze the entire means of communication from and to all parts of the country. Yet how was the calamity met? Within an hour of its occurrence the facilities afforded almost equaled the demand, and by the promptest and most vigorous action of General Eckert and his splendid corps of assistants the community were within a marvelously brief period in command of the ordinary facilities. Notwithstanding most stupendous difficulties in the intricacies of the situation, arrangements were so rapidly completed that really before the day was over hardly any one knew that a disaster so vast had occurred as to threaten an almost total

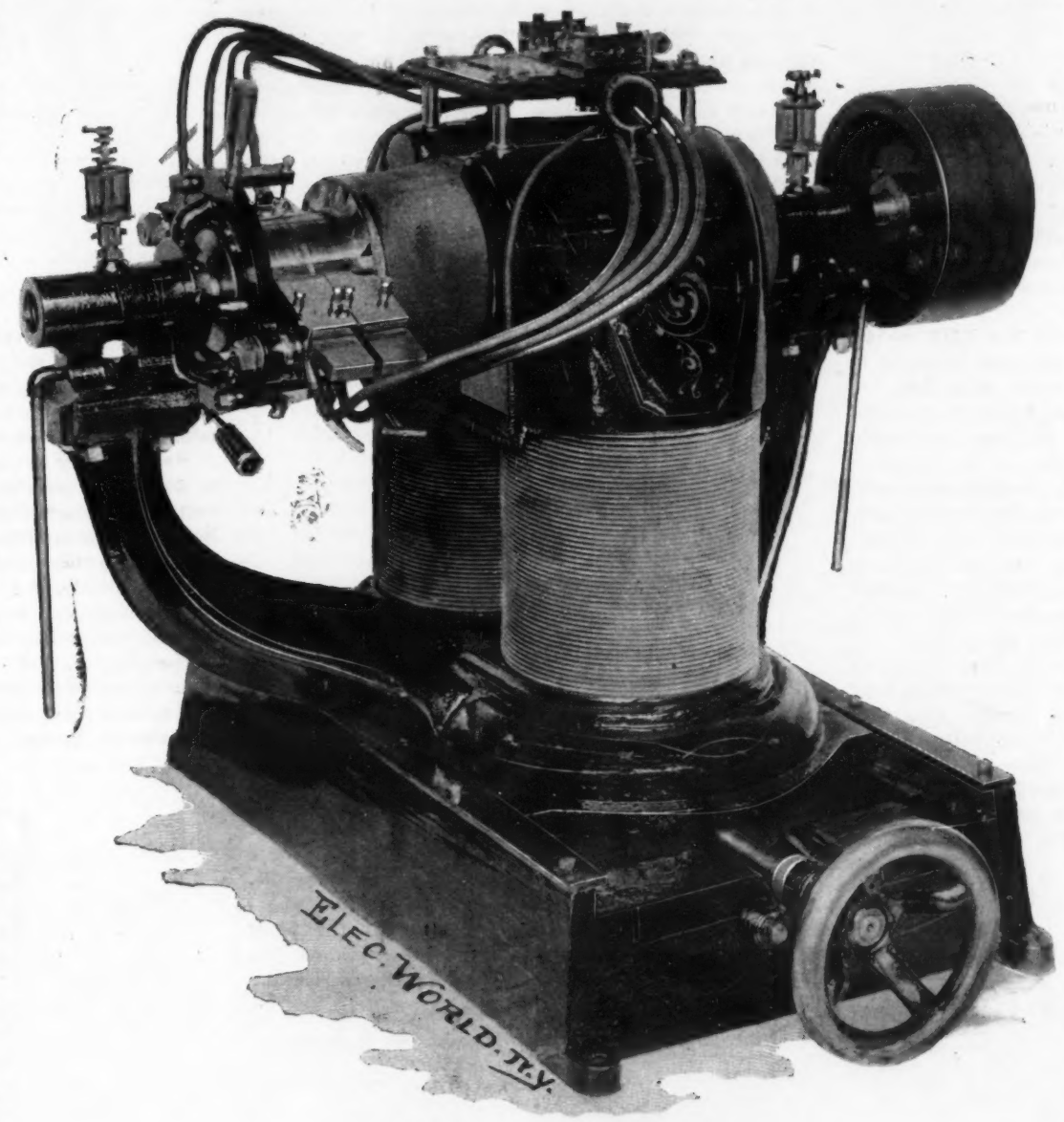
cessation of business in this, the chief centre of commerce. Even the newspapers, who rely so largely upon the telegraphic facilities, had the accustomed supply of news from all quarters of the globe, and without faltering, and without loss to an individual, this disaster, which threatened so much, caused little or no inconvenience.

How different such a condition would be in the hands of government employès under control from Washington, with the slight interest which, as a rule, government officers take in the affairs submitted to them. Of course there is good ability in governmental control, but the salaries of government officers are proverbially small, and the ability secured and permanently controlled in political offices is only that which fails to find employment in regular business enterprises. To imagine that a man like General Eckert, for instance, could remain a government official at a salary even equal to that of a Cabinet officer, when such splendid qualifications would command five times that figure in any great commercial enterprise, is to imagine a sacrifice too great even for patriotism to dictate. That men having judicial minds like Dr. Norvin Green could be compensated with less pecuniary profit or position than that of a Judge of the Supreme Court is not to be considered. That men like Colonel R. C. Clowry, of Chicago, whose control of the telegraph extends from the Pacific Ocean on the west to the Alleghany Mountains on the east, from the Minnesota border on the north to the Rio Grande on the south, could be put under the control of Postmaster-General Wanamaker, whose abilities fit him to run a bargain counter, is to expect that the contents of a quart measure could be put into a gill. Indeed, the Post-office Department, with its frequent changes, its political bossism, and its instrumentality as a fattening force for party purposes, is the last place in which an independent and really great electrician could find comfort, or peace of mind, or prospect of advancement. The day that the government assumes the control of the telegraph is the day in which it will paralyze the greatest, and best, and noblest means of communication that the continent possesses, and no event in the whole category of events could more seriously threaten the progress or prosperity of the country than the transfer of the means of instantaneous communication over its broad expanse to the clumsy, slow, changeful and uncertain control of the government.

A New Electroplating Dynamo.

Dynamos designed for work in electro-metallurgy must necessarily belong to a special type somewhat different from machines intended for ordinary lighting purposes. The electromotive force required for such service is very small, ranging from less than one volt to five or six for a single bath. As baths are ordinarily run in parallel, or only a very few in series, the extreme pressure required for commercial use is generally not over 10 or 15 volts. The quantity required is, however, enormous, as the depositing vats are generally connected with a considerable number in parallel, and the current required is in any case large. The dynamo was applied to electroplating as early as 1842, when the first patent on this subject was taken out, and about 1860 the Wilde machines for this purpose were quite extensively used. For the enormous flow of current required the armature is frequently wound with massive copper bars, and in any case must have conductors of very large cross-section. Some of the largest machines yield as high as 3,000 amperès.

The immense current around the armature in an electroplating machine frequently causes a large amount of disturbance of the field, and special care has to be taken with the design to avoid great changes of lead, and to secure anywhere nearly constant potential. The electroplating machine, illustrated herewith, is an excellent specimen of modern designing applied to this particular class of work. It was recently planned by Mr. Charles Kammeyer for the National Electric Manufacturing Company, of Eau Claire, Wis., and appears to be a very successful example of the electroplating dynamo. The details which we give were kindly furnished by Mr. Kammeyer. The machine, it will be observed, has field magnets of the inverted horseshoe type generally employed by the company in question, but differs somewhat in its relative dimensions from the standard machines. It is intended for an output of 7,500 watts, giving 500 amperès at an electromotive force of about 15 volts. The armature is 8 inches in diameter, 11¼ inches in length, and is wound with 16 coils, each composed of six No. 5 wires in parallel. The armature resistance is a little over .001 of an ohm. The field magnets are shunt wound and have a resistance of .6 of an ohm. The magnet is very powerful, so that there is little or no distortion of the field, even at the full output of the machine. The lead is small, not over 15 degrees, and does not change perceptibly between no load and full load. The non-sparking region is unusually wide and well defined, showing careful designing in the pole pieces. The field magnets are of cast iron throughout, while the armature is, of course, built up of soft charcoal discs. The normal speed is 1,050 revolutions per minute. The electromotive force at 100 ampères output is 15 volts, while at 500 ampères it falls only about 10 per cent., a good showing for so small a machine. The efficiency makes an excellent showing, as may be seen from the low armature resistance and the relatively high field resistance. Altogether it is a capital example of a comparatively small and very carefully constructed electroplating dynamo.



THE "NATIONAL" PLATING DYNAMO.

The Evolution of the Microphone.*

BY A. M. TANNER.

The object of the present paper is to demonstrate that the microphone did not spring into existence Minerva-like, but was the production of a slow growth continuing through several decades. It has several prototypes, as will be shown further on. In former articles, which appeared in the *Electrical Review* (Lon.), I drew attention to the fact that certain types of Trevelyan instruments, possessing carbon rockers and bearers, will, under certain conditions, serve as microphones, the most essential condition of course being that the rocking electrode should be made sufficiently light to be affected by ordinary sound waves. The instruments reviewed in the present article do not require a change of form or diminution of weight, but will at once serve as microphones or telephones, having variable contact current tension regulators. In the outset, in order to remove any doubt that may exist as to who first discovered the principle of varying the resistance in a galvanic circuit by electrodes of metal or other material resting in loose contact, one upon the other, and serving to change the tension of the current flowing across said electrodes, not by a mechanically applied pressure but automatically by a mere change of position or difference of contact between the electrodes, it is necessary to refer to the *Comptes Rendus* of the French Academy of Sciences for 1878, page 131, where Count Du Moncel states that it was not until the year 1856 that he discovered the change of electrical resistance produced by imperfect contact electrodes. This, of course, determines the date of Du Moncel's discovery, and in view of what follows, it is necessary to award the credit of prior discovery to Prof. Albert Mousson (just deceased at the age of 86 years), of Zurich. In the *Nouveaux Memoires de la Société Helvetique des Sciences Naturelles* for 1855, Vol. XIV., appears a lengthy paper of Prof. Mousson on the changes of the galvanic resistance of metals. Among other experiments, mention is made of the variable resistance between springs rubbing upon discs, just as in the electromagnetic circuit breakers of Du Moncel, when he discovered that a light or strong contact between the contact spring and collector disc will produce a variable resistance.

In Fig. 8 of the plate accompanying Mousson's article, he illustrates an experiment with two crossed wires, and he adds that in a loose contact *without pressure*, as when two solid wires are placed one upon the other, the resistance is variable because of the changes of position or changes of temperature at the contact points. The change of position of the loose contact electrodes is produced by the action of the current itself. (See Fig. 1.)

In the *Comple-Rendu* of the 45th session of the Société Suisse des Sciences Naturelles, Lausanne, 1861, is a communication from Prof. Mousson "on the movements that present themselves in a galvanic circuit at the points where the conductors touch each other very lightly." Mousson here describes the experiments of De la Rive in 1845, Rollman and Page in 1850, and Gore and Forbes in 1858, and says that they operated with rolling and rocking bodies.* Mousson, in describing his own experiments, says that for a "rocker" he selects a bar analogous to that employed in the Trevelyan experiment, only *very much lighter*, and resting upon two knife edges brought close together, set in motion; while the current traverses the point of contact a sound is produced which results from the rocking of the bar on the two knife edges (bearers) and which continues as long as the current passes. Mousson adds that the movement of the "rocker" does not commence by itself, but must be started by an external cause, although sometimes an *imperceptible trembling of a table serves to set it in motion.* In order to better study the conditions of the movements produced by parts of a galvanic circuit in loose contact, Mousson employed an instrument (Fig. 2) by means of which the pressure of the contact could be varied. The "restoring force which in the rocking bar is its weight" is here replaced by the "torsional elasticity of a metal wire secured at its lower end and stretched by means of a screw at its upper end. A small plate fixed at the middle of the length of the wire carries two platinum knife edges, which run parallel to the wire, and are brought close together and bear upon a clock bell (small gong). The current passes to the gong through the wire and contact points, and the tension of the spring and the pressure are easily regulated in order to produce continuous vibrations, which acquire considerable force if they are in accordance with one of the sounds of the gong." Mousson here describes the results which follow when the pressure between the contact points is varied. He says that when the pressure is at zero the mechanical and galvanic contact is interrupted, no current passes, and the needle of the galvanometer does not move. When a slight pressure is applied a mechanical contact takes place, but the galvanometer needle still remains at rest, because the galvanic contact is not yet established. This curious fact can no doubt be attributed to the *presence of a layer of condensed air*, which exists on the surface of all solid bodies, and which by resisting a slight pressure prevents metallic contact. When a greater pressure is applied it causes a mechanical and galvanic contact, but *it is always inconstant.* The needle oscillates constantly with greater or less force and is never in a state of repose. At the same time a slight hissing is heard like the long-continued sound of the consonant S. The current passes, but it constantly modifies the contact and the resistance presented by the same. Mousson attributes the change of resistance to calorific effects at the contact points, and says that the "variations of contact are produced without interruption of the current."

An illustration of Prof. Mousson's instrument as above described is found in his work "Die Physik auf Grundlaye der Erfahrung," Zurich, 1874, vol. 3, page 412, Fig. 942. The article relating to "movements produced by parts in light contact" describes the instrument as follows, viz., "The torsional elasticity of a strong wire, *A*, as

*From the *Electrical Review* (London).

* These experiments and others were described in my previous articles.

shown in Fig. 942, serves to hold contacts together. The wire is provided at the middle with an arm, *B*, clamped to the wire, and provided with two knife edges of platinum, which latter are held against a harmonic bell, *C*, conforming to the vibrations of the wire. When the current enters the bell at *a* and passes out through the bell shank, light vibrations are caused by the agitation of the lever, which are reinforced by the bell and are heard as a clear tone of considerable loudness.

I think it is almost needless to add that Prof. Mousson's instrument, as above described and illustrated, becomes a veritable microphone when "spoken to," and will transmit speech when used in connection with a telephone receiver. To show how carefully he studied the phenomena that are supposed to take place at variable contact electrodes, it is only necessary to say that Mr. Berliner, and others, have attributed the action of the microphone to the action of a "layer of condensed gas between the electrodes." Mousson, it will be seen, makes mention of this phenomenon. Then, again, transmitting telephones have been constructed where the electrodes are held in contact by a torsion spring, very much as in the Mousson instrument.

I now call attention to other references which disclose instruments that have a close bearing upon certain special types of microphones. It is undoubtedly well known to

Fig. 1.

those conversant with the history of the microphone as disclosed by text-books, that the microphone of Boudet de Paris has a series of carbon balls placed in a glass tube, and which operate by impact, as "in the billiard ball experiment."

The French journal, *Cosmos*, for 1858, Vol. XIII., p. 148, has an article by Van Breda and Lorgeman intended to prove Ampère's law of repulsion. They state that "in carrying out their experiment they employed 12 iron balls, of some eight or nine millimetres in diameter, suspended as the billiard balls in the experiment on the impact of bodies, the centres of the ball being in line with each other. The two end balls have points which dip into mercury cups that are in communication with the poles of a battery of 12 Grove elements. When the current is made to traverse the balls the two end balls are repelled from the others about one millimetre, and sparks are observed between each pair of balls." (See Fig. 3.)

Wiedemann, in his work "Die Lehre der Electricität," in referring to this last described experiment, which may be illustrated by the accompanying sketch, says that the passage of the current through the balls is attended by variations in its flow, according to the degree of contact of the balls and the calorific effects between the same. Wiedemann also states that the formation of sparks and the voltaic arc, together with the expansion of the

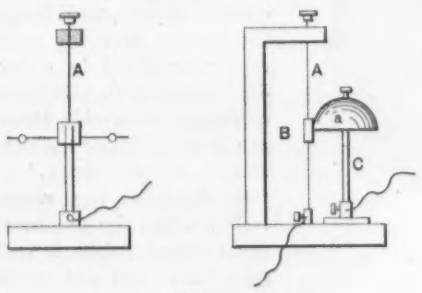


Fig. 2.

electrodes by the calorific action of the current, can give rise to a vibratory movement of the electrodes between which such actions take place. If two carbon points are fastened to two elastic wires, which, by their pressure hold the electrodes together horizontally, then when the electric circuit is closed a "clattering" noise like a series of small explosions is heard, and the passage of sparks and the formation of the electric arc between the electrodes is heard. The vibrations produced in this manner are imparted to the wires, and can be viewed and felt by the fingers. (See Fig. 4.)

Mr. Berliner and others, in order to disprove the theory that the microphonic action is produced by a film of rarefied or heated air between the electrodes, placed the latter in a vacuum chamber. It is not necessary for me to describe the result of these experiments; but in this connection I call attention to the experiments of Reitlinger, described in the *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften*, Vienna, 1862, page 453. The article is entitled "Tones and some Phenomena of Motion Produced in the Closed Circuit of a Galvanic Current." After reviewing the experiments of Paalzow, Forbes, Gore, and others,* and stating that the electrode of an electrical Trevelyan instrument will rock under water, he describes certain experiments performed in a vacuum cham-

*Reviewed in my former articles.—A. M. T.

ber with a sheet iron semi-cylindrical rocker resting upon knife-edge bearers. The experiment can be illustrated by the following sketch. (See Fig. 5.)

In this experiment it was not necessary to start the rocking motion by an impulse; the electric current passing across the contact points produced the rocking motion. Reitlinger, like others before him, attributed the rocking motion to electro-dynamic repulsion, and to disprove the "heated air" theory he performed the

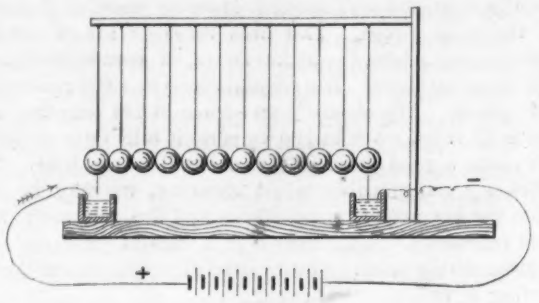


Fig. 3.

operation in a vacuum. The close analogy to microphone contacts in a vacuum is apparent.

In Poggendorff's *Annalen der Chemie und Physik*, Vol. 124, 1865, Buff describes his experiments on the production of sound by electricity. After referring to prior experiments of Poggendorff, who placed a sheet metal tube, slit lengthwise, around an electromagnet, and produced tones in the metal cylinder when the edges of the slit were in incomplete contact, an interrupted current was passed through the electromagnet. Buff describes his own experiments, which I have illustrated by the sketches below. In sketch Fig. 6 the slit sheet metal cylinder of Poggendorff is used as a transmitter, in which currents are induced by an interior electromagnet, through which inter-

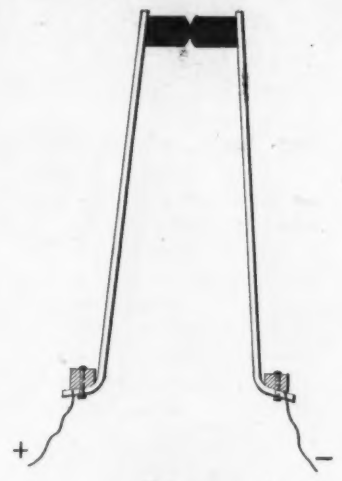


Fig. 4.

mittent currents are passed. The receiving instrument is a brass plate, upon which rests a needle electrode that will set the plate in vibration. It is stated that the cause of this vibration is due to "the incomplete contact and consequent increase of resistance at the contact points between the needle and the plate." It is also stated that "when the point of incomplete contact is made of a piece of fine platinum wire, or fine sewing needle, whose *slightly oxidized* points rest upon the plate, then with a current of suitable strength the point is heated to incandescence, and then when the current is not too rapidly interrupted a perceptible varia-

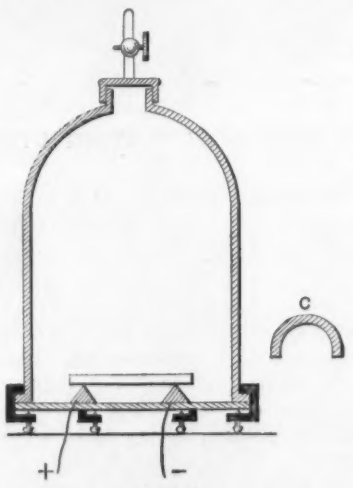


Fig. 5.

tion of the incandescence phenomena at the contact points is observed. It is apparent that similar variations, although not visible to the eye, are present when the contact points are not heated so much. If this theory is accepted then the sound produced is due to heat effects at the contact points." Referring to Buff sketch, Fig. 7, the description which warrants the same states that a metal plate rests upon a sounding box, and that two needle electrodes bear loosely upon said plate and are connected with the secondary circuit of an induction coil. The primary circuit of this coil contains a circuit breaker which may be either a rotary "make and break" or a mercury cup in which a wire is immersed that is drawn out to break the circuit. In this connection, and as having a very pertinent bearing upon the question as to whether the arrangement with a mercury circuit breaker will not produce a practically continuous induced current, I cite the "Archives de l'Electricité," Vol. V., 1845, p. 222, in which De La Rive, in his article on the production of musical sounds by intermittent currents, says:

"A mercury rheotome produces more sustained sounds and slighter shocks, since by the same the interruption of the current is more gradual and not sudden as with a toothed wheel, this being due to the fact that a slight amount of mercury always adheres to and goes out with the needle when the latter is drawn out of the mercury." In this connection I also cite "Etude sur la Téléphonie," by Dr. Rothen, Berne, 1888, p. 93, where Prof. Hughes is quoted as saying that in the reversibility of the microphone (as receiver) the vibration of the diaphragm is in

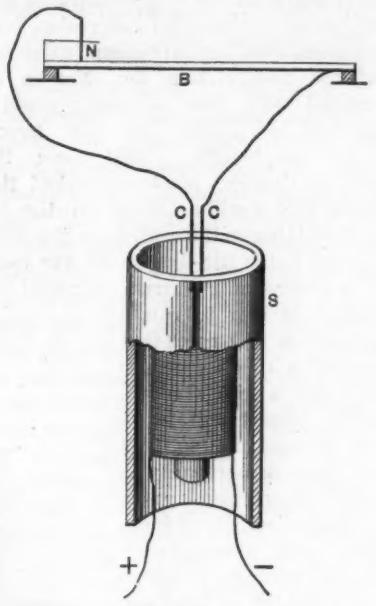


Fig. 6.

consequence of the variations of the temperature at the point of contact, and that the expansion and recession of the material (contact) produce blows against the diaphragm and hence cause the same to vibrate. Those who are familiar with the French microphone of Pollard and Garnier will readily perceive that the "microphone receiver" of Buff closely resembles the same, since both have sliding rod shaped electrodes resting loosely upon a diaphragm. Before closing my review of references which, in my opinion, deprive the *instrumentalities* used in the modern microphone almost if not entirely of all novelty, I wish to call attention to a newly published fact that I have discovered concerning the Reis telephone. In the *Annales Télégraphiques*, Vol. VII., 1864, p. 592, it is stated that "the telephone of Reis would be an admirable instrument if it realized in a perfect manner the hopes of the theory. Without prejudging the future, it is well to recognize

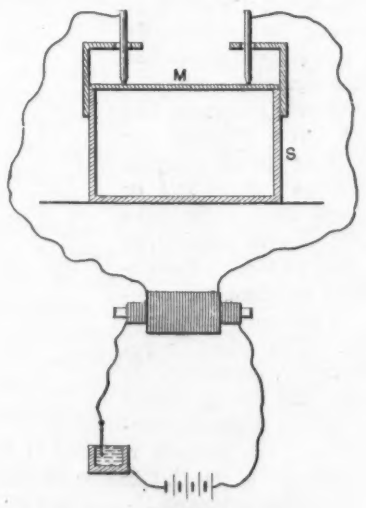


Fig. 7.

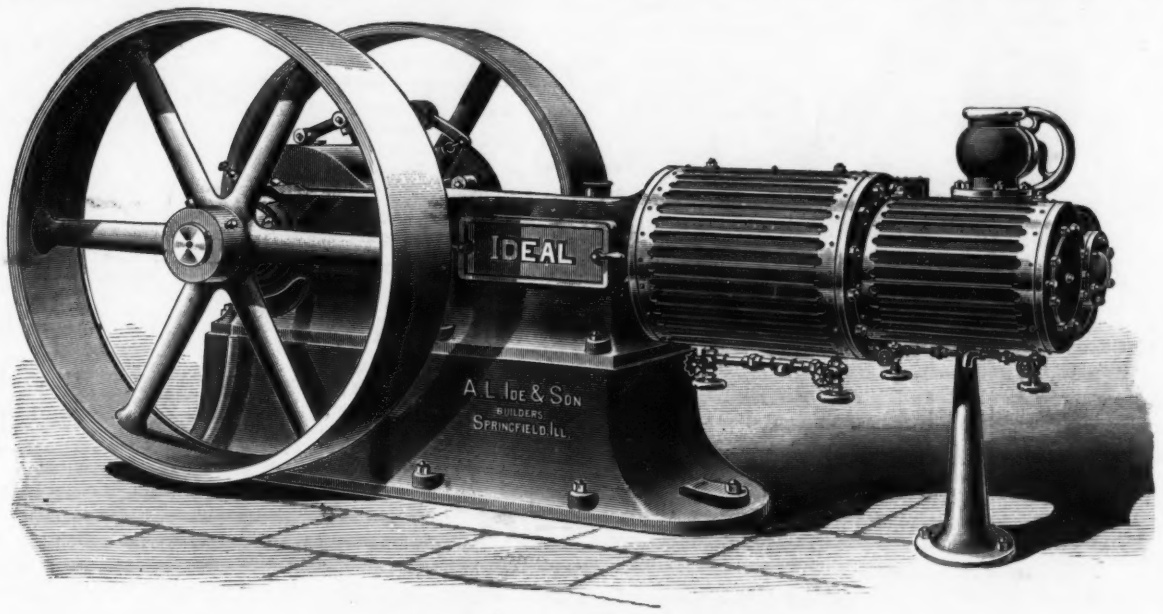
that it is not yet perfect. When the gamut is produced at the transmitter it takes a well-trained ear in order to recognize the sounds in the midst of the vibrations (tremblements) to which it is subjected. Besides this, the model instrument of which we speak is exposed to several causes of error, since the membrane will, at certain moments, not vibrate with the same amplitude, thus occasioning at times want of contact. If the sound emitted rests *within* neighboring limits *the contact is prolonged*. This inconvenience is avoided by substituting for the operator's voice a tuning fork furnished with a vibrator (systeme trembleur), then the note is more precise, although always very weak."

It is not my intention to detract from the merit of the discovery that the loose contact electrodes of Mousson, Rollman and others can be set into vibration by the human voice, and thus used for the transmission of speech, the object of the present article being mainly to show that almost all the theories advanced concerning the operation of microphonic contacts were known many years ago, and, as at present, there were men at that time adherents of the "repulsion," "heated air," "arc," and "condensed

air" theories. As I stated at the commencement of my present article, the microphone did not require the discovery of the principle that light electrodes placed in loose contact will, by a change of position, or the diminution and increase of the contact surfaces, serve to effect a change in the tension of a current flowing across said contacts. This phenomenon was carefully studied by Prof. Mousson, and it only remained for Prof. Hughes to select a known form of variable contact rheostat, just as Bell and Gray used a liquid rheostat in their original experiments. A mercury rheostat, it may be added, was also used in Prof. Mousson's experiments, and he considered the same the equivalent of solid metal bodies placed in loose contact one upon the other.

The Seafert Dynamo and Motor.

For the regulation of dynamos and motors a large number of plans have been from time to time adopted. So far as constant potential machines are concerned regulation is comparatively simple, for a properly designed shunt or compound winding will keep electromotive force constant with all the exactness that is ever required in practice. With constant current machines, however, the problem is very much more difficult and a vast amount of ingenuity has been spent in devising various solutions for it. The present machine, designed by Mr. William Seafert, of Chicago, possesses some interest from the regulation being accomplished in a very unusual manner. Weakening the field of the dynamo of course lowers the electromotive force produced, and if this weakening can be made proportional to the lessening demand for electromotive force the current can be kept substantially constant. In the Seafert dynamo the method employed for weakening the field is by increasing the air gap and at the same time lessening the amount of armature subject to induction. In other words, it can be considered an ingenious combination of the two forms of regulation, consisting, first, of increasing the air gap, as is sometimes done by moving the fields; and, secondly, slipping the armature out of the field to still further lessen the induction through it. Both these methods have been individually employed, the latter by the well known Crocker-Wheeler Co. Mr. Seafert, however, accomplishes both these ends at once by making the armature in the form of the frustum of a cone, so that when it is slipped axially away from the field the air gap will at the same time be increased; and consequently a small movement will produce a considerable weakening of field. The arrangement is a very convenient and advantageous one, especially for small machines. Any number of motors may be operated in series, and the armature of each will under the influence of the automatic regulator take a position in accordance with the demands at the moment. In the cut is shown a dynamo and two motors. The dynamo is shown with its armature in a position which gives somewhat less than the maximum of electromotive force, while one of the motors is running at full load and the other, the armature of which is partly withdrawn, with a rather light load. This regulation may be extended to any number of machines, and as the governor controlling the position of the armature may be made quite sensitive and a small motion produces relatively great weakening of the field, there is every reason to expect close regulation. The dynamo can, of course, be used for lighting purposes, in which case the position of the armature would depend upon the number of lamps in circuit. The arrangement is best adapted to rather small constant current machines. The armature is relatively large and of the Gramme construction, thus giving a powerful torque and a moderate speed of rotation.



THE IDEAL COMPOUND ENGINE.

The Ideal Compound Engine.

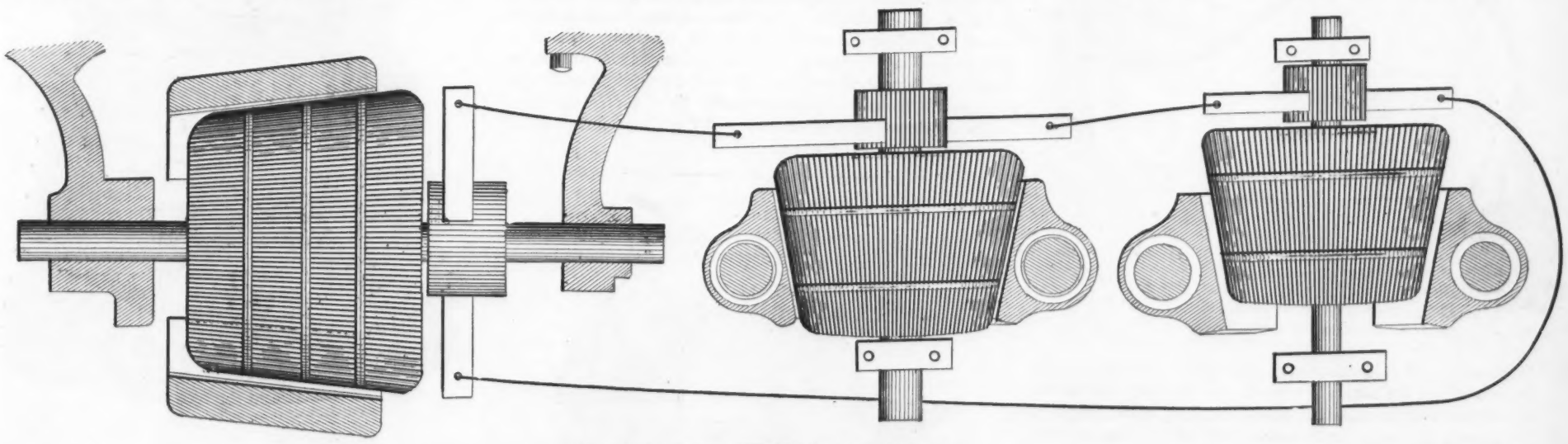
In the design of this engine illustrated on this page the builders have had in mind the requirements of electric lighting and power service, and have aimed to produce a reliable and simple engine of great strength and durability.

The frame and general design of the tandem compound Ideal engine is the same as the well-known Ideal single expansion engine. It has the same heavy self-contained main frame with overhanging wheels, all bearings being self-oiling with working parts enclosed, insuring thorough and continuous lubrication of all working parts, thus reducing the wear, preventing hot bearings and effecting a great saving in oil and attendance. It is guaranteed that the speed will not vary two per cent. when working under extreme changes of load. The engines are tested under these conditions before they are sent out.

The cylinders are arranged on the tandem plan, and are so proportioned as to give a high efficiency. The low pressure cylinder is bolted direct to the engine bed, and to the head of this cylinder is cast the high pressure cylinder. By this arrangement steam from the high pressure cylinder has a short direct passage into the low pressure cylinder without suffering loss of heat by passing through connecting pipes or receiver. With this construction excellent results have been obtained, and a minimum of steam per horse power is used. Another feature of this arrangement is that four stuffing boxes are dispensed with on the piston and valve rods between cylinders, reducing the friction and radiating surfaces. The head between cylinders is cored out leaving a large space, which is filled with a non-conducting compound. This is said to effectually prevent the heat from passing through, thus securing a uniform high temperature in the high pressure cylinder. Both cylinders and steam chests are encased with a paneled iron jacket, with two inch air space between cylinder and jacket, which is filled with a non-conducting material. Both cylinder heads are protected in the same manner, to prevent loss of heat.

Both valves of the engine are controlled by the governor, and are on the same stem, moving together, and varying in stroke as the load and steam pressure vary, thus giving the advantage of automatic cut-off in both cylinders, and dispensing with the mechanism of double eccentrics, rocker-arms, slides and stuffing boxes as sometimes used. The high pressure cylinder has a piston valve similar to that used on all Ideal engines, but double ported on the compound in order to give larger areas for free admission of steam. The low pressure cylinder has a flat balanced valve, traveling under a cover and supported on hardened steel rollers, and is so arranged that steam is admitted through three ports, thus giving a quick wide opening at the beginning of the stroke in order to reduce the pressure on the exhaust end of the high pressure piston. The cover of this valve is held in place by a spring, and will lift, and prevent excessive pressure in the cylinder from water or other causes. Provision is made for conveniently adjusting the cover to take up wear, so the valve will remain steam tight. Both valves are perfectly balanced, and with full boiler pressure can be moved by hand with ease. The steam ports are very large, short and direct. The valves have a long travel, giving a quick opening and close.

The governor is of the same type as that in use for eight years on the Ide engines and is susceptible of accurate adjustment, and when so adjusted the dash-pot affords the necessary stability to insure isochronous action and an excellent regulation of speed. It is simple in construction, reliable and durable. By recent improvements the use of oil on the governor bearings is dispensed with. All parts of the engines are fitted to standard templets and gauges and are interchangeable.



THE SEAFERT DYNAMO AND MOTOR.

The Most Favorable Position for an Electric Light Central Station.*

BY DR. A. FOPPL.

As the question very frequently arises as to which is the best situation for a central station so far as the cost of mains is concerned, the following simple considerations, which do not require any complicated calculations, may be of use:

If there are any number of points 1, 2, 3 . . . which may be regarded as centres for distribution, the mains to these points from the central station O must obviously, if practicable, lie in straight lines. Suppose $l_1\ l_2\ l_3\ \ldots$ to be the lengths of these mains and $c_1\ c_2\ c_3\ \ldots$ the respective currents they will be called on to carry. The weight of copper required for the main l_1 will then be $k\ c_1\ l_1^2$, where k is a coefficient depending on the tension, and, therefore, in our case a constant. The total weight of copper required for the mains is accordingly $k \Sigma c\ l^2$, the sum being taken over all the distributing centres of the system. But this expression is of the same form as that for the moment of inertia about 0 of masses proportional to $c_1\ c_2\ c_3$ placed at the distributing centres. But the moment of inertia is a minimum when the point about which it is taken is the centre of gravity of the system. We accordingly have the law: The weight of copper required for the mains will be a minimum when the central station is placed at the centre of gravity of the system formed by placing masses proportional to the current consumed at each one of the disturbing centres. Further, we know that the moment of inertia about any point distant r from the centre of gravity of any system is equal to the moment of inertia about the centre of gravity $+ r^2 \Sigma m$. From this we deduce the law that the weight of copper in the mains is the same when the central station is at any point on the circumference of a circle, described with the centre of gravity, as determined above, for centre.

In order to apply the laws found to an example, the centre of gravity as defined is first found. Various values are then put for the moment of inertia about a point, and the distance of the point accordingly from the centre of gravity determined. These distances are taken as radii, and concentric circles are drawn with the centre of gravity for centre. It is then possible to see at a single glance

* From the *Elektrotechnische Zeitschrift*.

the increase per cent. in weight of copper in the mains necessitated by removing the central station to any distance from the centre of gravity.

The Bassett Combination Lamp Support.

One of the strongest evidences of the commercial establishment of electricity, and all that pertains to it, is shown in the effort of electrical companies to produce useful and popular articles at a moderate cost. As an evidence of this effort to place good apparatus upon the market, the Electrical Supply Company, of Chicago, has lately introduced the Bassett combination portable and bracket lamp support. This device is intended either for desk or

FIG. 1.—BASSETT'S PORTABLE.

table use, as in Fig. 1, or for a simple and convenient wall bracket, Fig. 2. It is often desirable to combine the two for convenience as well as economy, while heretofore separate articles have been necessary. The Bassett combination portable and bracket is of brass, neatly and strongly made, and ought to meet with considerable success where practical convenience is of importance.

Wisconsin Electric Club.

At the annual meeting of the Wisconsin Electric Club, held last week at Milwaukee, the following officers were elected for the ensuing year: President, A. J. Rogers; vice-presidents, J. D. McLeod, E. C. Wall, W. S. Johnson, Geo. H. Benzenberg, D. J. Whittemore; secretary, H. F. Boggis; treasurer, W. H. Hyde; board of managers, T. E. Parker, A. J. Shaw, Geo. Glassner, Henry Campbell, Jr.; S. G. Colman; committee on membership, John A. McManman, H. D. Goodwin, H. P. Andrae. Reports were read by the retiring officers of the club, showing that the organization is on a sound financial basis, and that it has grown in members and interest during the past year.

President A. J. Rogers, in his remarks, referred to the

FIG. 2.—BASSETT'S BRACKET.

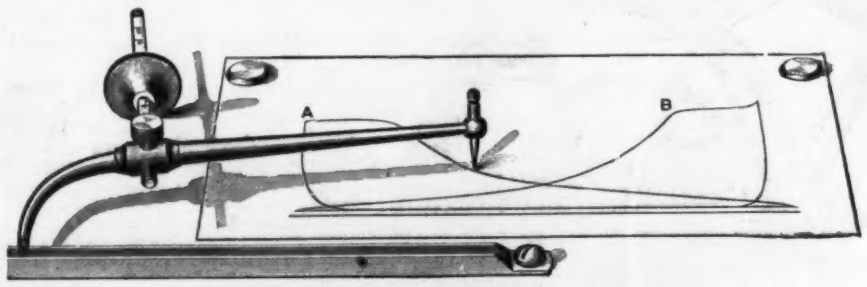
interesting and valuable papers that had been given, and other work of the club. He spoke of the progress made during the year in applications of electricity to telegraphy, telephony, lighting, temperature regulation, fire alarm, transmission of power, and metallurgy.

A New Planimeter.

We show herewith a new planimeter which will be of interest to those of our readers—and they are many—who have occasion to take and compute indicator cards. None of the rough and ready rules for computing the area of cards are particularly simple in their application, or accurate in results; and where it is desired to keep a record of the output of an engine the planimeter is a highly desirable instrument, and should be purchased as a necessary part of the indicators. The present instrument differs very considerably from those in ordinary use, and is possessed of some points of great convenience. As is well known to those who have occasion to use the planimeter an occasional source of trouble is the necessity of the recording wheel traveling sidewise. Of course it should accomplish this without revolution, but it does not always do so unless the instrument is very carefully managed.

The present integrating machine is designed for the special purpose of furnishing a ready means for measuring indicator diagrams simply and rapidly. From its construction, it will be observed that the slipping motion of the wheel in running over or on to the card is in a very large measure avoided. The record wheel is knife-edged and free to move on its spindle, and reads by the distance it has traveled along its axis, instead of with a vernier as is usual. In operating the instrument it is only necessary to slip the wheel against the shoulder which forms the zero point on the scale, and then trace the diagram with the pressure point from the upper left corner of each card, pressing in the direction in which the hands of a clock move. The scale engraved on the spindle gives, on completing the tracing, the number of square inches in the card.

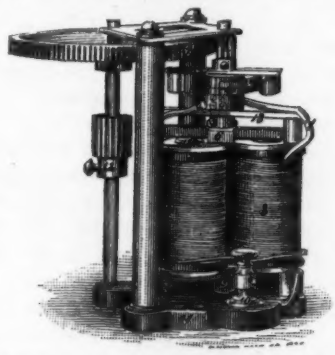
This new instrument is said to work very satisfactorily for the purpose intended, and is highly recommended by Messrs. Hine & Robertson, who make a specialty of furnishing these power measuring appliances. Its merits are simplicity, and the ease and rapidity with which it can be manipulated, without special delicacy in adjustment.



HINE AND ROBERTSON'S PLANIMETER.

A Motor for Window Displays.

The accompanying illustration shows a type of motor which, from its simplicity and compact form, is admirably adapted to the use to which it has recently been put by the manufacturers, the proprietors of the Bush Revolving

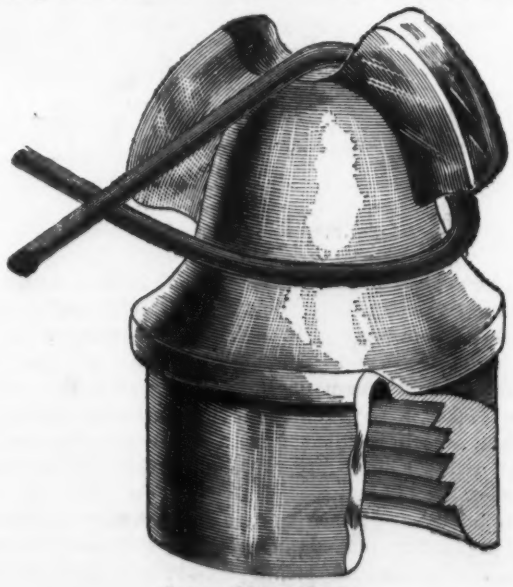


MOTOR FOR WINDOW DISPLAYS.

Store Fixture Company, 24 Park Place, who have charge of it in this city. As will be seen from the illustration there are three field magnets set side by side in a vertical position. The shaft carrying the armatures, which revolve above and below the spools, is placed vertically between the field coils. The projections of the armatures are such that there is no dead centre. By an intermediate gear the motion of the shaft is communicated to a revolving table upon which any desired display, up to perhaps 200 pounds in weight, may be arranged.

A Cable Insulator.

We present herewith a cut of a large cable insulator made by the Oakman Manufacturing Company, of South

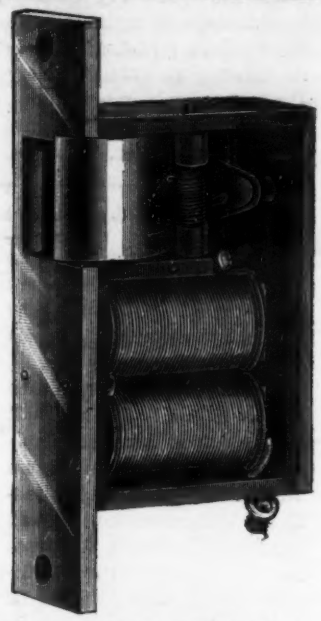


CABLE INSULATOR.

Boston, Mass., and designed especially for carrying heavy wire stretched in unusual positions. By means of the cleats at the top of the insulator the cable can be carried from it, up or down, or off at any angle, and its dimensions are sufficient to accommodate cables up to two inches in diameter. It has proved convenient for railway work, and is being considerably used for that purpose where large field wires have to be carried around curves in some unusual position. Its insulating properties are excellent.

"Positive" Electric Door Opener.

The accompanying illustration shows clearly the parts of the "Positive" door opener, which is manufactured and sold by the inventors, Messrs. Seib & Starkie, 148th street, this city. When the electric button is pressed the armature leaves its contact and presses against the back spring, which in turn acts on the centre spring, and this releases the latch and opens the door. When



"POSITIVE" DOOR OPENER.

the door is again closed the parts resume their former position, and remain there until again put in action.

Bain's Glass Insulator.

The accompanying illustration shows a new high resistance glass insulator, the invention of Mr. Forée Bain of Chicago. The insulator is made extra strong and is especially adapted to heavy work, such as carrying large primary wires, and particularly feeder wires for electric railroad work. The corrugations which are made both outside and inside of the apron increase the distance from the wire to the pin fully 100 per cent., and it is claimed that water will, in passing over the edges of the rings, be obstructed, and on reaching the inside of the glass will drop off rather than creep over the inner obstructions to the pin. Another point which is claimed in favor of this form of insulator is

BAIN'S GLASS INSULATOR.

that the many surfaces will reflect the light under the glass in such a way as to keep insects out, obviating a source of much annoyance where plain dark glass is employed. The inventor claims that an advance of a few cents per mile in the cost of construction will not be any objection where a high class of work is desired.

Mr. Bain has assigned his patent to the Central Electric Company, of Chicago, and this company is now placing the insulator upon the market.

Board of Electrical Control.

The main point of interest at the meeting of the Board of Electrical Control on the 4th inst. was the statement by Mr. Lauterbach, the President of the Consolidated Telegraph and Electrical Subway Company, that a new development had taken place with a view of more effectively carrying on the subway work. A company called the Empire City Subway Company has just been formed, consisting of persons interested in telegraph and telephone companies, and this company is to take charge of the low tension busi

ness of the subways. Mr. Lauterbach pointed out that the business of his company had increased to such an extent that the co-operation of another company was needed. The consolidated company would still retain its control of the high tension subways, but at the same time, if the electric lighting companies found themselves in a position to formulate a feasible plan for assuming the work now carried out by his company, it was quite within the bounds of possibility that such an arrangement might be negotiated. The consent of the Board was asked for the proposed transfer of business, and the matter will be considered at an early date. The question of the excessive rentals charged for the use of the subways was again raised, but as a judicial decision on this question, which is now being argued in the courts, was expected in a day or two, action was deferred until Monday, when the Board expected to be in a position to take up the subject.

Notes on the Chemistry of Secondary Cells.

BY PROF. W. E. AYRTON, VICE-PRESIDENT; C. G. LAMB, B. SC., AND E. W. SMITH, ASSOCIATES.

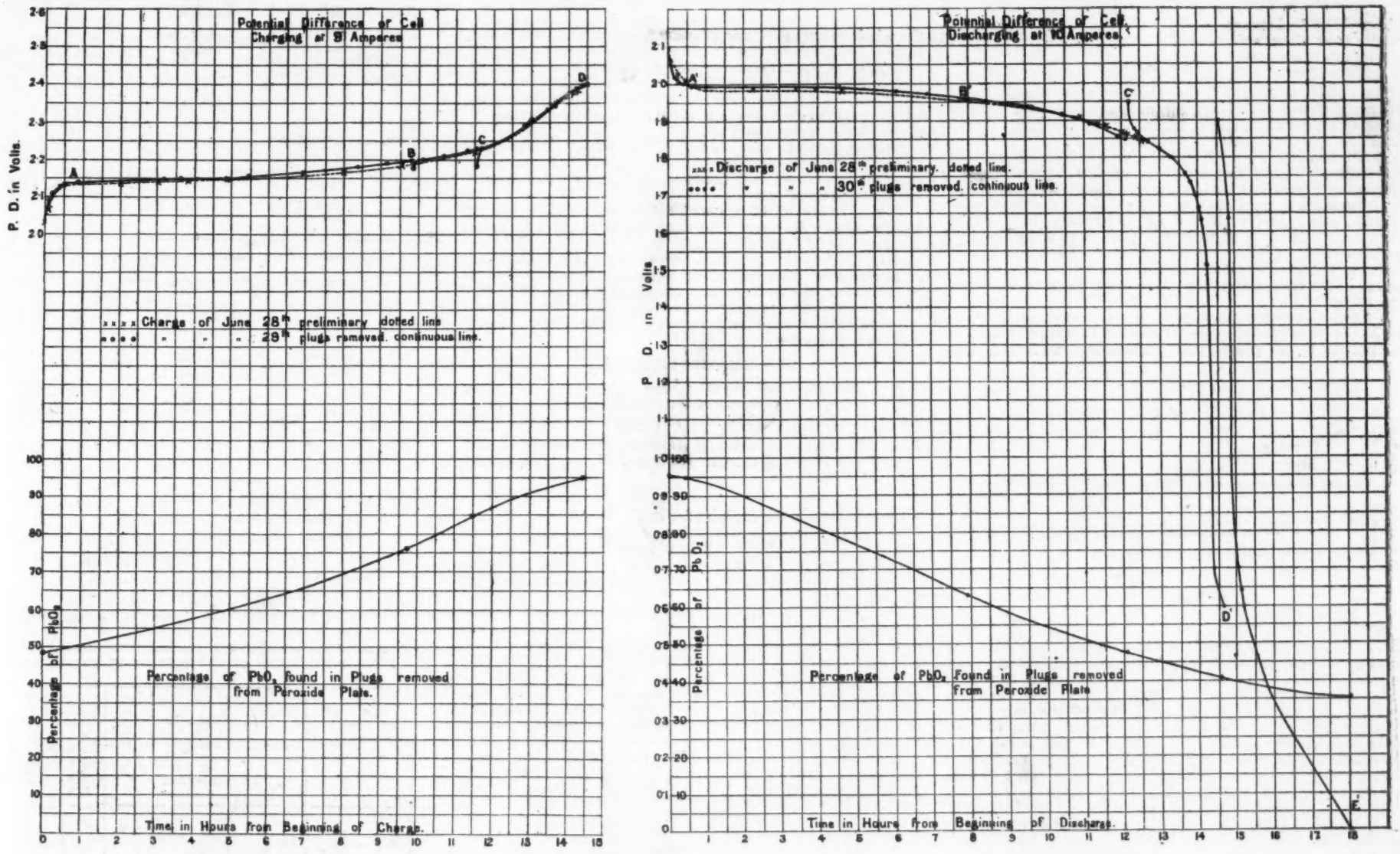
In our paper on "The Working Efficiency of Secondary Cells," read at the meeting of this Institution in Edinburgh in July, it was stated that, "In spite of accumulators with pasted plates having been in use now for nine years, the chemical action that takes place during the different stages of the charge and discharge has only been conjectured, and, odd as it seems, no decisive experiment appears to have been made to settle this much-debated question. Various analyses have been made by different chemists of salts of lead acted on in certain ways with sulphuric acid, but apparently not of actual accumulator plates in action. We are therefore now, with the assistance of Mr. Robertson, making a complete investigation of the chemical state of the plugs of both the positive and negative plates at all stages of the charge and discharge of an 1888 E. P. S. type of accumulator in good condition." The present paper contains an account of the results thus obtained.

The cell selected to remove the plugs from had the same size as the cells employed in the investigations described in the previous communication, and was one of the batch of 50 purchased for the Central Institution about the middle of 1888. Since it first came into our possession it had never been overcharged, never been left discharged, nor permitted to send more than the maximum current allowed by the makers for cells of this size—viz., 10 ampères—and consequently, at the beginning of the present investigation in June of this year, this cell was in excellent condition.

First the cell was several times charged with a current of nine ampères, and discharged with a current of 10, without stopping day or night, so as to bring it into what we have called its steady "working" state. The dotted curves Figs. 1 and 2 show the large charge and discharge obtained on June 28. During the next charge, indicated by the continuous curve, Fig. 1, plugs were removed from both the positive and the negative plates at the points marked *A*, *B*, *C*, and *D*, when the terminal P. D. of the cell was 2.134, 2.2, 2.234, and 2.4 volts respectively. In order to remove the plugs from the positive plates, these plates were bodily removed out of the liquid, but, to prevent oxidation, the negative plates were left in the liquid, and the plugs removed in a way that will be described later on. The time occupied in removing the plugs from the two sets of plates occupied about 15 to 20 minutes on each occasion. Immediately after the removal of the plugs the positive plates were put back in position in the cell, the resistance in the circuit rapidly adjusted, if necessary, to make the charging current exactly nine ampères, and the time variation of the P. D. at the terminals of the cell noted. The interval that elapsed while the current was broken is not shown on the curve; that is to say, the P. D. observed immediately after replacing the positive plates in the liquid and closing the circuit is plotted directly under the P. D. that was observed just before the circuit was broken, prior to the removal of the positive plates from the liquid.

We were afraid that the bodily withdrawal of the positive plates out of the liquid, combined with the removal of the plugs, on the several occasions, would produce so great a change in the conditions of the cell as to render the P.D. curve quite discontinuous. It was, therefore, as interesting as it was unexpected to find that the terminal P. D., on restarting the normal charging current of nine ampères, rapidly acquired the value it had before the withdrawal of the plates; so that, with the exception of the rapid rise of the P. D. on restarting the charging current, the P. D. curve obtained on June 29 was almost the same as the P. D. curve obtained on charging on the previous day.

After the cell had been charged until the terminal P. D. reached 2.4 volts, it was immediately discharged with a perfectly constant current of 10 ampères, and, as it was anticipated that the removal of the plugs would spoil the cell, it was allowed to discharge far below the normal limit. In previous discharges (the last one of which is shown by the dotted line, Fig. 2) the discharge was stopped when the terminal P. D. fell to 1.85 volts. But in the discharge on June 30, when the plugs were removed, the discharge current was kept at 10 ampères, by using auxiliary cells, until the E.M.F. of the test cell fell to naught, and even reversed. Plugs were removed from both the positive and the negative plates when the terminal P. D. was 2, 1.95, 1.85, 0.6, and naught volts, as indicated by the points *A'*, *B'*, *C'*, *D'*, and *E'*. The recovery of the E.M.F. on breaking the circuit was very marked, especially near the end of the discharge.


Potential Difference of Cell Charging at 9 Amperes
P. D. in Volts.
A
B
C
D
xxxx Charge of June 28th preliminary dotted line
•••• " " " 28th plugs removed. continuous line.
Percentage of PbO2
Percentage of PbO2 found in Plugs removed from Peroxide Plate.
Time in Hours from Beginning of Charge.
Potential Difference of Cell Discharging at 10 Amperes
A'
B'
C'
D'
E'
xxxx Discharge of June 28th preliminary. dotted line.
•••• " " " 30th plugs removed. continuous line.
Percentage of PbO2 Found in Plugs removed from Peroxide Plate
Time in Hours from Beginning of Discharge.

FIGS. 1 AND 2.—CHEMISTRY OF SECONDARY CELLS.

II.—METHOD OF OBTAINING SAMPLES OF THE PLUGS.

On the first removal of plugs corresponding with the point *A* (Fig. 1), a curved pointed glass rod was used, as shown in Fig. 3, with the idea of prizing out the plugs; but by this method only the surface of the positive plugs could be removed, as they were much too hard to be loosened in this way. Indeed, one of the most striking things noticed in this investigation was the firm way in which the plugs were held in the plates of an E. P. S. cell that had been carefully used for two years. Before the next attempt was made to remove plugs corresponding with the point *B* (Fig. 1), a straight piece of glass rod was pointed and mounted in a wooden handle. This glass chisel was used to pierce and lossen the positive plugs, which were then driven bodily out of the grid by means of a hard wooden punch cut square to fit the holes in the grid, and which was tapped with a small mallet. The plugs on being driven out of the grid were caught in a long wooden scoop (shaped so that it could be just slipped in between the plates), and then washed by Mr. Robertson in wide-mouthed bottles containing three or four hundred c.c. of distilled water. As soon as the water cleared it was decanted off and fresh added.

As several glass chisels were broken, and the wooden punches worn down in the removal of the plugs, the method had the disadvantage of mixing with the specimens to be analyzed splinters of glass and wood, which were found difficult to remove afterward. On the other hand, the method had the advantage of enabling specimens of the positive plugs to be removed in a comparatively short time on each occasion from the top, the middle, and the bottom of the plates.

As the negative plates were never removed from the acid, the only way to remove the plugs was by working them loose under the liquid by means of long curved glass rods pointed at the end, and by catching the plugs in a narrow wooden scoop with a long handle, as shown in Fig. 4. It was possible to use this method throughout for the removal of the negative plugs, as they were softer and more easily removable than the positive ones. The scoop held sufficient liquid to enable the negative plugs to be dropped into wide-necked bottles containing water without the plugs being even momentarily exposed to the air. The water in these bottles Mr. Robertson had washed free from dissolved oxygen by previously bubbling hydrogen through it for a considerable time. After the negative plugs had been put into the bottles the water was gradually decanted off from time to time, and fresh added until the liquid was quite free from acid.

Both in the case of the positives and the negatives the top samples were removed from the corner of the plates nearest the lug, and the bottom samples from the corner diametrically opposite, so as to obtain evidence, if possible, of any difference of current-density which might exist at different parts of the plates in charging and discharging.

The plugs from the top, the middle, and the bottom of each set of plates were at each of the removals of plugs put into six separate bottles, and, to avoid the possibility of error in their subsequent identification, there was noted on the label of each the character of the plates and the position on them from which the plugs were removed, the time, the P. D., and the specific gravity of the liquid in the cell.

III.—APPEARANCE OF PLATES AT REMOVALS OF PLUGS.

The following notes were made by Mr. Robertson and ourselves at the successive removals of the plugs:

CHARGING.

POSITIVE PLATES.	*NEGATIVE PLATES.*
Point A on Curve 1. *Terminal P. D.*, 2.134 *volts. Specific Gravity of Liquid*, 1.178.	
The upper part of the plates had a grayish-brown color, and presented the appearance of being coated with a very thin film of white sulphate. The lower part of the plates was of a reddish-brown color. The plugs at the top were hard, while those at the bottom were quite soft.	The plugs at the top were the softest.
Point B on Curve 1. *Terminal P. D.*, 2.1 *volts. Specific Gravity of Liquid*, 1.198.	
The plates had entirely lost their whitish appearance, and showed a uniform reddish-brown color, darker than the previous color of the bottom of the plates.	The plugs both at the top and at the bottom harder than before, those at the top having hardened more than those at the bottom.
Point C on Curve 1. *Terminal P. D.*, 2.234 *volts. Specific Gravity of Liquid*, 1.201.	
The previous charges increased in amount.	The previous charges increased in amount.

Point D on Curve 1. *Terminal P.D.*, 2.4 *volts. Specific Gravity of Liquid*, 1.206.

The plates had the rich deep brown color of lead peroxide, except where they were covered with the ebonite separators: there the color was lighter.

The plugs had a brilliant metallic lustre, and looked quite silvery when first removed from the plates. The plugs at the top were now the hardest.

The plugs at the top were slightly the softest, while those at the bottom were much the same as at the beginning.

DISCHARGING.

POSITIVE PLATES. *NEGATIVE PLATES.*

Point A' on Curve 2. *Terminal P. D.*, 1.998 *volts. Specific Gravity of Liquid*, 1.205.

The plugs at the top were harder than those at the bottom.

The plugs had the brilliant metallic lustre observed at the end of the charging.

Point C on Curve 2. *Terminal P.D.*, 1.850 *volts. Specific Gravity of Liquid*, 1.180.

The plugs had become much harder.

The plates had become decidedly white, and the plugs were white right through.

Point D on Curve 2. *Terminal P. D.*, 0.6 *volt. Specific Gravity of Liquid*, 1.175.

The plugs had become extremely hard, especially at the bottom.

The plugs were somewhat softer.

oint E on Curve 2. *Terminal P. D.*, 0 *volt. Specific Gravity of Liquid*, 1·172.

The plugs had become so hard that they splintered and bits flew about on trying to remove them.

The bubbling of gas from the negative plates ceased when the terminal P. D. on discharging fell to 1.85 volts (point *C* on curve 2), and it began again when the terminal P. D. fell to somewhere near zero.

The following Figs. (5 and 6) give an idea of the way in which we found the hardness of the top and bottom plugs of the positive and the negative plates respectively to vary during a normal charge. The figures are not drawn to scale, as we had no standard of hardness beyond our sensations; hence the figures only profess to be qualitative sketches from which mental pictures can be obtained. Distance measured upward from *O A* indicates roughly the degree of hardness; distance measured downward the degree of softness.

It will be seen that during the charging the variation in the hardness of the plugs is far greater at the top than at the bottom of the plates, and consistently with this fact

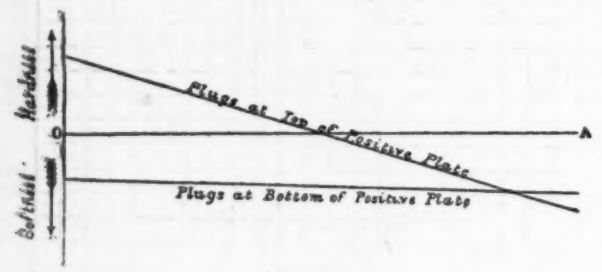


Fig. 5.

Mr. Robertson's analyses show that, on the whole, the rate of chemical action at the top of the plates is greater than at the bottom. The difference in the hardness, however, is far more marked than the difference in the chemical action. For example, while the plugs at the top of the positive plates are, during the earlier part of the charging, much harder than those at the bottom, no such striking difference is observable in the percentage of lead peroxide contained in these plugs. The cause of this we are examining experimentally at the present time.

In order to see how far the resistance of the lead grid would tend to make the current density in the upper part of the liquid less than in the lower, as well as for the purpose of seeing how large a fraction of the whole resistance of the accumulators was due to the lead lugs and to the connections between the successive pairs of lugs, the following tests were made by three of the students—Messrs. Hobson, Lee and Montealegre:

Parts of the lead lugs of some of the accumulators were scraped, and on these clean spots binding screws, which had been themselves filed bright, were tightly screwed. The accumulators were allowed to send measured currents, the values of which are given in the following tables, and the P. D. between the pairs of binding screws was carefully measured with a sensitive reflecting voltmeter. The resistance of the lugs between the pairs of binding screws is then at once obtained by dividing the P. D. by the current.

Figure.	Position of Binding Screws.	State of Nut and Screw T.	Length of Lug in Inches.	Current in Ampères	P. D. in Volts.	Resistance in Ohms.
7	*A* and *D*			8	0.00187	0.000230
	A and *C*		3.25	8	0.00117	0.000150
	A and *B*		1.5	8	0.00060	0.000070
	T and *A*	Dirty	Wire pressed on at T	8	0.00038	0.000047
		Clean		8	0.00028	0.000035
		Dirty	Wire screwed on at T	8	0.00028	0.000035
		Clean		8	0.00025	0.000031
8	*E* and *H*		6.5	8	0.00219	0.000270
	F and *H*		4.0	8	0.00128	0.000160
			1 5	8	0.00049	0.000060
	G and *H*	Dirty		8	0.00021	0.000030
	T and *H*	Clean		8	0.00021	0.000030
9	*K* and *L*	Dirty		8	0.00522	0.000650
	T and *O*	Dirty		8	0.00063	0.000080
		Clean		8	0.00057	0.000070
	K and *L*	Very dirty	13	5	0.00500	0.001000
	T and *O*	Very dirty		3	0.00524	0.001750
		Clean		10	0.00044	0.000044

From this it appears that the resistance per inch of the lug alone is about 0.000043 ohm, and that the resistance at the contact of two lugs which were tightly screwed together when quite clean, but which have become very dirty from the acid spray falling on them, may be as high as 0.001 ohm, or 30 times the resistance of an inch of the lug itself. The resistance between *T* and *O* (Fig. 9) being greater than between *K* and *L*, when *T* was very dirty, is probably explained by the fact that when the wire was screwed under *T* to test the resistance between *T* and *O* (Fig. 9), it was screwed against an exceptionally dirty bit of the lug.

As we have shown in the Edinburgh paper, the mean resistance from positive lug to negative lug of one of these accumulators *complete* is about 0.004 ohm when the contacts between the lugs and the testing wires are made quite clean. Hence it appears that about one-seventh of

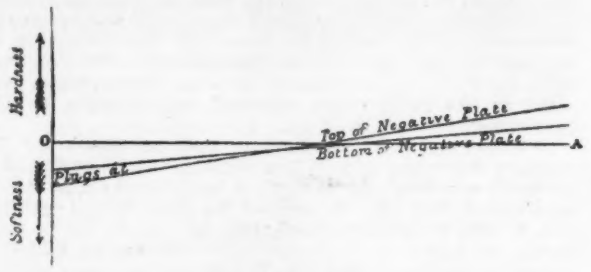


Fig. 6.

the whole mean resistance of such an accumulator is caused by the resistance of the lead lugs themselves; and that the resistance of such accumulators as we have been experimenting with can, when joined up in series, be increased by 25 per cent. if the contacts be allowed to become dirty by the acid spray falling on them, even although they remain all tightly screwed up.

Since these tests were made we have had all the accumulators disconnected, the contacts carefully cleaned and tightly screwed up, and the nuts and screws then coated with hot paraffine wax.

The coarsely divided paraffined cork, which is sold by Messrs. Drake & Gorman for floating on the tops of accumulators to filter the hydrogen gas from sulphuric acid spray, was most successful in stopping the acid fumes from escaping into the room when we first obtained it. As, however, the cork became thoroughly wetted with the liquid, its filtering property was much diminished. It appears to us that there still remains the need for a really good spray-arrester.

IV.—ANALYSIS OF PLUGS.

The following is the report of the analyses of the plugs removed at different stages of the charging and discharging, which Mr. Robertson has been so kind as to prepare for us:

Report by G. H. Robertson on Analyses made in the Chemical Department of the Central Institution of Plugs from an E. P. S. Cell.

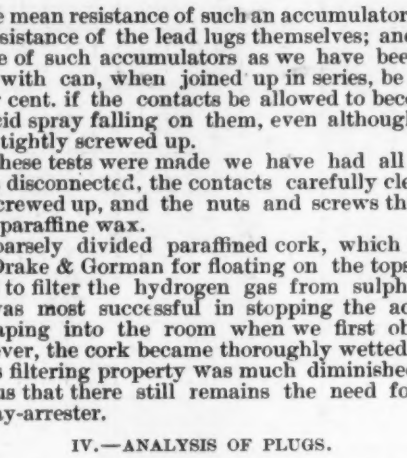
Oct. 16, 1890.

Preparation of the samples for analysis:

The positive samples were taken separately, washed on to filters and thoroughly freed from acid. In every case the samples from the bottom were harder to wash than the others, and the residues were dried for some hours at about 120 degrees C.

The samples were now ground up fine in an agate mortar and the splinters of wood and glass removed as far as possible. The approximate weights for analysis were now taken and redried on watch glasses at about 140 degrees C.

At first the substance for analysis was dissolved in a porcelain dish, and the insoluble residue of sulphate was filtered off, with the intention of determining the amount of sulphate by the ammonium acetate method; but owing to the small amount of material available, and the error introduced by the solubility of lead sulphate in the nitric acid used to dissolve the sample, the attempt to determine both the peroxide and the sulphate was abandoned, and



Figs. 3 and 4.

the samples were used to determine the peroxide only as accurately as possible. This course was justified by the fact that very careful qualitative experiments showed that nothing but peroxide and sulphate were present in the plugs.

The method employed to determine the peroxide was the ammonium oxalate and permanganate method described in Sutton's "Volumetric Analysis," as in previous analyses it had been found very sensitive; and the solutions were checked about every two days against pure lead peroxide, and each day the solutions were run against each other, but they were not found to alter practically in the time they lasted. The first lot of ammonium oxalate was standardized against permanganate which had been very accurately standardized against iron, and by the nitrometer method.

Using this solution, "pure" lead peroxide, as purchased, and which afforded a slight white residue like silica, contained 97.3 per cent. as the mean of a large number of analyses made with different weights; and any subsequent solution which gave the percentage between 97.2 and 97.5, inclusive, was taken as correct. It will be noticed that *D* and *A'* gave practically the same percentage as the sample of pure lead peroxide.

LEAD PEROXIDE FORMED ON THE POSITIVE PLATES DURING CHARGE

	Percentage of PbO_2.	Mean.	Mean increase in percentage PbO_2 and time interval.	Total hours ch'ge.	P. D. in volts just		Specific gravity of liquid.
					Before breaking circuit.	After closing circuit.	
	Top..... 30.6, 31.0, 32.7	31.43		H. M.			
*A**	Middle.. 35.23, 35.34	35.28	34.5*	0 37	2.134	2.122	1.178
	Bottom 36.5, 37.3, 36.6	36.80					
			41.0*, H. M. 9 11				
	Top..... 77.0	77.00					
B	Middle.. 76.1, 76.8	6.45	75.5	9 48	2.2	2.186	1.198
	Bottom 73.2, 73.3	73.25					
			8.8, 1 49				
	Top..... 88.0	88.00					
C	Middle.. 85.15, 84.72	84.93	84.3	11 37	2.234	2.186	1.201
	Bottom 79.8, 80.3	80.05					
			10.8, 2 50				
	Top..... 96.3, 96.8	96.5					
D	Middle 94.1, 93.42	93.76	95.1	14 27	2.4	....	1.206
	Bottom 95.00, 95.11	95.05					

* Only the surface of the positive plugs was removed in the first attempt, *A*.

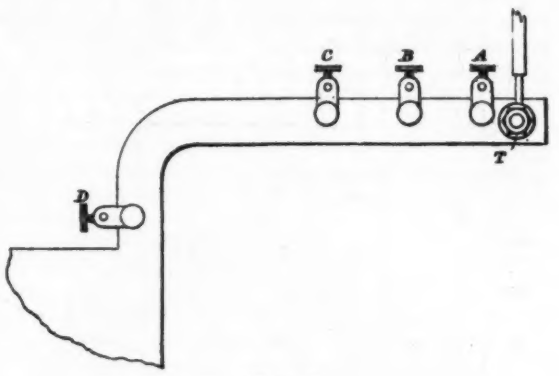


Fig. 7.

LEAD PEROXIDE REDUCED ON THE POSITIVE PLATES DURING DISCHARGE.

	Percentage of PbO_2.	Mean.	Mean Increase in Percentage PbO_2, and Time Interval.	Total Hours Disch'ge.	P.D. in Volts just		Specific Gravity of Liquid.
					Before Breaking Circuit.	After Closing Circuit	
	Top..... 96.7, 97.0	96.85		H.M.			
A'	Middle. 94.88, 94.37	94.62	94.9	0 25	1.998	2.002	1.205
	Bottom 93.4, 93.1	93.25					
			31.7, H. M. 7 27				
	Top. 67.5, 67.06, 67.0	67.2					
B'	Middle. 64.82, 64.25	64.53	63.2	7 52	1 956	1.958	1.189
	Bottom 57.9, 57.7	57.8					
			15.3, 4 16				
	Top 49.0, 48.8, 48.8, 48.3	48.7					
C'	Middle.. 49.92, 50.5, 50.2	50.45	47.9	12 8	1.850	1.902	1.180
	Bottom 44.07, 44.90	44.48					
			6.5, 2 29				
	Top..... 41.8, 44.01, 43.9	43.2					
D'	Middle. 42.70, 42.92	42.81	41.4	14 37	0.6	1.9	1.175
	Bottom 37.9, 38.6	38.25					
			5.4, 3 26				
E'	Mixed . 36.6, 36.7, 34.8	36.00		18 3	Zero indefinite on reversing circuit.	E M F makes circuit.	1.172

The residues from the samples containing the highest percentage of peroxide of lead were white, those from the

samples containing the smaller percentage were brownish-white; and it was noticed that if the larger grains were crushed under the end of a glass rod they had a dark centre of peroxide, which at once dissolved, leaving a slight yellowish-white insoluble ring. By grinding the sample very fine in the mortar, so as to break up the capsules of sulphate more thoroughly, the residue was got lighter in color; and using a flask to boil the substance in, the residue becomes perfectly white, but this yellowish-brown tinge to the sulphate does not seem to be due to any appreciable quantity of undissolved peroxide, as practically identical percentages were obtained with pure white and yellowish residues. Dark residues gave low results.

In the case of the very hard plugs, there was some error from the glass and wood, which could not be picked out altogether, though the samples were picked over very carefully (*cf. D'*, *E'*).

In the case of the negative plates, the sulphate was in such a loose and powdery condition that it fell off and adhered to the insides of the bottles used for receiving the plugs in, and it was quite impossible to obtain representative samples for quantitative analysis; so qualitative tests had to be made, which, in the case of charge, showed nothing but sulphate of lead and lead, the sulphate decreasing during charge until at *D* there was practically nothing but pure lead.

During discharge the sulphate increased; at *C'* there was a doubtful indication of peroxide of lead, and at *D'* and *E'* there was decided evidence of peroxide. After a few days the plugs were white all over, and there was no difference in appearance between the front and back. The water had no acid reaction.

For the sake of comparison the percentage of $Pb O_2$ at *A* in the following table is taken as 47.9, as at *C'*.

The calculations refer to mean values of $Pb O_2$, and the values of P. D. before breaking circuit.

	Interval.	Increase per hour in percentage $Pb O_2$.	Percentage increase in P. D. in interval.	Percentage increase in $Pb O_2$ in interval.
CHARGE.	*A* to *B*.....	3.0	3.1	27.6
	B to *C*.....	4.8	1.6	8.8
	C to *D*.....	3.8	7.4	10.8
	Interval.	**Decrease per hour in percentage $Pb O_2$.**	**Percentage decrease in P. D. in interval.**	**Percentage decrease in $Pb O_2$ in interval.**
DISCHARGE.	*A'* to *B'*.....	4.3	2.1	31.7
	B' to *C'*.....	3.6	5.4	15.3
	C' to *D'*.....	2.6	67.4	6.5
	D' to *E'*.....	1.6	100.0	5.4

The screening influence of lead sulphate is clearly brought out in this table. Between *A* and *B* the surface film and

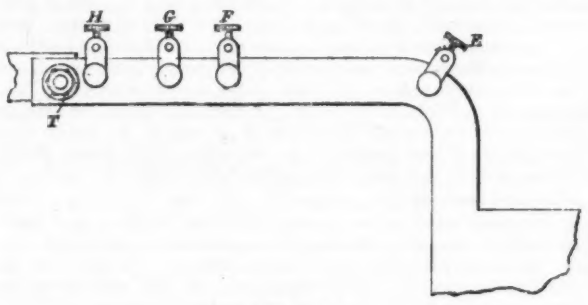


FIG. 8.

the coatings on the partially reduced granules of $Pb O_2$ are got rid of; then between *B* and *C* the pure lead sulphate is attacked; and finally, between *C* and *D*, with the removal of the last traces we get a very rapid rise in volts P. D.

It will be observed that:

(*a*) The particles of the peroxide very soon get coated in the discharge with a layer of lead sulphate, which protects the peroxide from further action, as shown by the examination of the dark-colored residues which contained peroxide, and which were rendered very hard to dissolve by the coating of sulphate.

(*b*) The analysis also shows what a large proportion of active material is still remaining at the end of the discharge. This has been remarked on by many experimenters.

(*c*) The loose powdery surface of the positive plate seems to be thoroughly converted into lead sulphate. *C* and *B'* dissolved readily, leaving pure white residues.

(*d*) When the peroxide in the surface of the plate falls to about 31 per cent. the cell loses its E. M. F. very rapidly, owing to the inactive layer of sulphate impeding the action of the sulphuric acid on the active material behind it, and also to the formation of peroxide on the negatives. The diffusivity of the acid is decreasing, and it has to penetrate further into the plate to find active material. When the whole of the paste approaches this composition of 31 per cent. peroxide, the cell loses its E. M. F. entirely.

(*e*) The action seems to take place most rapidly where the current density is greatest; the plate gets hard there from sulphate soonest on discharge, and oxidizes quickest on charge.

Planté and Messrs. Gladstone and Tribe have both noticed the formation of peroxide of lead on the negative plate during discharge, and pointed out that once it is formed more rapidly than it is reduced, the two plates must rapidly approach electrical equilibrium; that when the circuit is broken local action alone can take place, and this will reduce the peroxide on the negative plate, and on making the circuit again the cell will again give a current; and in this way Messrs. Gladstone and Tribe account for the resuscitating power of the cell, as well as for the rise of E. M. F. on breaking the discharging circuit.

I have to acknowledge the facilities afforded me for seeing the plugs as they were removed, and the care taken to let me have the samples in good condition.

I am also indebted to Professor Armstrong for his invaluable advice and assistance in the execution of the work.

G. H. ROBERTSON.

From the mean results of the preceding analysis carried out by Mr. Robertson, we have drawn the curves seen in the lower part of Figs. 1 and 2, and which show the percentage of $Pb O_2$ found in the plugs of the positive plate at all stages of the charge and discharge. In the $Pb O_2$ curve for charge the first point is obtained from the analysis of the plugs at the end of the normal discharge; that is, when the terminal P. D. had fallen to 1.85 volts, indicated by the point *C'* in Fig. 2. The percentage of $Pb O_2$ actually found in the positive plugs at the point indicated by *A* (Fig. 1) does not lie on the $Pb O_2$ curve as drawn, but, as already indicated, this arises from the specimens removed from the plugs at experiment *A* being only scrapings off the surface, and therefore not representing the average constitution of the plugs. On all subsequent occasions when specimens were removed from the plates, whole plugs, as already stated, were detached. The analysis at the point *A* (Fig. 1) was, therefore, abnormal, and the percentage of $Pb O_2$ obtained for this point, and which is given in the table, is not indicated on the curve.

If the energy given out by the cell be produced by the conversion of the $Pb O_2$ in the positive plugs, and of Pb in the negative, into lead sulphate, a constant value of the P. D. at the terminals of the cell when a constant current

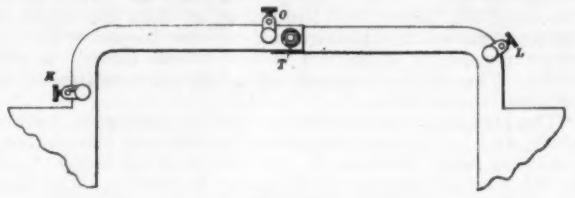


FIG. 9.

is passing through it ought to correspond with a constant rate of variation of the percentage of $Pb O_2$ in the positive plugs; so that for a constant current

$$\text{the terminal P.D. should} \propto \frac{d\,(Pb\,O_2)}{dt},$$

t representing time. This connection is seen to exist fairly well in the case of the discharge where the slope of the $Pb O_2$ curve is roughly constant as long as the P. D. is constant, and acquires a less inclination to the axis of time when the P. D. is rapidly falling. In the case of the charge, the connection between the value of the P. D. and the slope of the $Pb O_2$ curve is not so easily seen; but this arises from the fact that towards the end of the charging there is a rapid rise in the resistance of a cell, and therefore in the P. D. required to send a constant current through it; further, the back E. M. F. steadily increases during charging on account of the polarization, which grows larger and larger from the continuous evolution of gas at the surface of the plates.

As already explained, the constant discharge current of 10 ampères was, by the employment of some auxiliary cells, kept flowing through the accumulator under test even when its E. M. F. became very small. Toward the end of the discharge the fall of P. D. at the terminals of the cell under test became extremely rapid, so that, for example, on closing the circuit after the removal of the plugs at *D'* (Fig. 2), the P. D. fell from 1.9 to 0.6 volts in 39 minutes, as seen from Fig. 10. This rapid fall is probably due to lead peroxide being formed on the negative plates more rapidly than it could be removed by local action, since the chemical analysis showed decided evidences of lead peroxide on the plugs removed at *D'* from the negative plates. At *E'* (Fig. 2) the E. M. F. of the accumulator under test became reversed, but rapidly recovered its original direction on stopping the discharge current, as seen from Fig. 11.

It is a very striking example of the recuperative action of a secondary cell that you can completely discharge it, as you think, and then even charge it in the wrong direction, but it will, on being insulated, rapidly recover an E. M. F. in the original direction. Indeed, we were told of a curious case some time back. After the removal of the laboratory employed for testing ammeters from one part of a well-known London factory to another, it was found that the E. P. S. accumulators always ran down very rapidly whenever an attempt was made to use them, in spite of their having been charged in the intervals. As the E. M. F. was always in the right direction, it was supposed that the cells had become partially short-circuited in the removal, and it was not for some time that the true explanation of the refusal of the cells to do their work was discovered. The real fact was that, in fitting up the new laboratory, the leads from the dynamo to the switch had

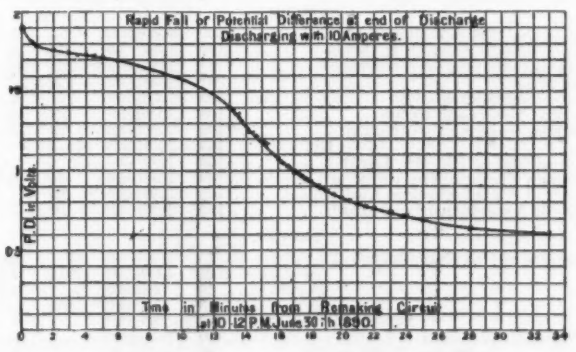

Rapid Fall of Potential Difference at end of Discharge Discharging with 10 Amperes.
P.D. in Volts.
Time in Minutes from Breaking Circuit at 10 12 P.M. June 30th 1890.

FIG. 10.

been reversed, so that the unfortunate cells were charged in the wrong direction every time the dynamo was turned on.

The preceding incident also forcibly illustrates the sort of attention that secondary cells may receive in practice, and shows the necessity for the P. D. and specific gravity being occasionally measured even in places where the study of the behavior of cells is not the main business of the factory.

One of the great defects of the earlier specimens of the E. P. S. cells lay in the buckling of the plates. Mr. Capito tells us that it was Mr. Collet who noticed that all the plates generally curved in one direction, and who suspected that this arose from the unequal chemical action on the two sides of the last positive plate of the cell. Mr. Collet, therefore, proposed putting a negative plate at each end of this cell, and this plan—which has been always followed since—of using one more negative than positive plate, has had much to do with removal of the buckling difficulty.

V.—EFFECT OF REST ON CHARGED ACCUMULATORS.

As the result of a number of tests described in our Edinburgh paper, we found that if E. P. S. accumulators be charged with nine ampères and discharged with 10, a number of times without intermission, between the P. D. limits of 1.8 and 2.4 volts per cell, until the cells are brought to a perfectly steady "working state" the quantity efficiency is about 97 per cent., and the energy efficiency 87; further, that if the cells be fully charged until the P. D. per cell is 2.4 volts, and then be left perfectly insulated for 16 days, the next discharge between the fixed P. D. limits only gives out about 65 per cent. of the ampère hours, and about 57 per cent. of the energy put in before the rest. Further, not merely is energy lost during the rest of an insulated accumulator, but for several subsequent charges and discharges between the same P. D. limits after the rest the storage capacity and the quantity and energy efficiencies are all lower than before the rest.

For the purpose of examining into what took place in an accumulator which was left charged, a small E. P. S. cell was charged until the P. D. was 2.4 volts, and the positive plates were withdrawn and put into another vessel containing dilute acid of specific gravity 1.2, the negatives being left in the vessel in which they were charged. Both sets of plates were covered up with gutta-percha hoods the edges of which dipped under the liquid, and to the top of each hood was fitted, gas-tight, a vertical graduated glass tube closed at the top. The hoods and the glass tubes were first filled with liquid, and the amount of gas that came off from the two sets of plates was measured from day to day by watching the descent of the liquid in the tubes.

No gas was seen to come off from the positive plates, but in the case of the negatives gas came off very slowly at first, then more rapidly, and finally more slowly again. The following table gives a record of the amount of gas that came off from the negative plates, the gas, on analysis, being found to be hydrogen*:

HYDROGEN GAS COLLECTED FROM CHARGED NEGATIVE PLATES AFTER REMOVAL OF POSITIVE PLATES.

Date.	Time. H.	Time. M.	Cubic centimetres of gas collected.	Time of collecting gas in hours.
Nov. 15.....	11	45	0	0
" 17.....	10	0	2	46
" 20.....	12	0	52	120
" 21.....	10	0	72	142
" 22.....	10	0	87	166

If the lead of the positive plate be turned into lead sulphate by local action, 87 c.c. of hydrogen liberated corresponds with about 0.81 gramme of lead turned into sulphate. It is clear, then, that the lead of the negative plate is steadily being turned into some oxide or salt, and probably the loss of energy which we observed in the charged cell left insulated for many days was due to this local action at the negative plate. And further, as this action takes place apparently only at the negative plate, it is clear that in the subsequent discharge the cell will appear to be discharged before the positive place is discharged, and charged up again without reducing all the lead sulphate on the negative plate. The local action at the negative plate while a cell is standing charged has, therefore, for the first few discharges and charges after a long rest, exactly the same effect as if a portion of the negative plate had been bodily removed out of the cell. Hence we see that the peculiarities observed by us in curves 8 to 23 in our Edinburgh paper may be explained by this defective behavior of the negative plates.

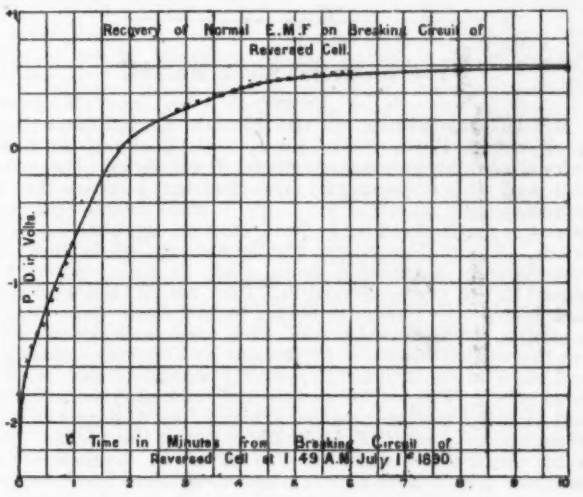

Recovery of Normal E.M.F on Breaking Circuit of Reversed Cell.
P.D. in Volts.
Time in Minutes from Breaking Circuit of Reversed Cell at 1 49 A.M. July 1st 1890.

FIG. 11.

VI.—CONSTRUCTION AND FORMATION OF E. P. S. PLATES.

The question arises why the E. P. S. accumulators are so constructed that the plugs in the positive plates contain some 48 per cent. more peroxide of lead than is required to be converted into sulphate in the normal discharge. Two explanations suggest themselves. One is that, since the granules of lead peroxide began, as we find, to be coated with a protecting coating of sulphate early in the discharge, it is impossible, with the present form of plate, for the interior of each granule of lead peroxide to be converted into sulphate, and therefore it is necessary to employ nearly twice as much lead peroxide as is actually needed for the chemical action. Another reason is the fear of the positive plate crumbling to pieces if it be completely formed: and this reason Mr. Capito, who was formerly in the employ of the Electrical Power Storage Company, thinks, on the whole, is the more important.

In the construction of the original Faure accumulators, as well as of the E. P. S. cells, both the positive and the negative plates were pasted with red lead ($Pb_3 O_4$), and formed together for a period of some 50 hours. Later on litharge (Pb O) was used to coat the negative plate, red lead being used only for the positive one, and the plates were formed separately, the negative being much more formed at the works than the positive. Some time ago I was informed by a very competent authority that the following is the modern process of *forming* employed by the Electrical Power Storage Company:

Positive Plates.—$8\frac{1}{4}'' \times 7\frac{1}{4}'' \times \frac{1}{4}''$. Two ampères per plate, or 0.028 ampère per square inch, sent for 18 hours.

Negative Plates.—$9'' \times 9\frac{1}{4}'' \times \frac{3}{16}''$. One and a half to

* Since the preparation of this paper we have noticed that Dr. Gladstone and Mr. Hibbert, in their paper communicated this summer to the Physical Society, have also observed that hydrogen comes off from a charged negative plate of a secondary cell when left idle.

two ampères per plate, *i. e.*, 0.017 to 0.023 ampères per square inch, for 120 hours.

The actual time of forming either set of plates depends greatly on the length of stoppages during the formation. This is especially the case with the negative plates; therefore they endeavor to form the negatives for the 120 hours without any stoppage of the current. On the receipt of a cell from the Electrical Construction Corporation, the purchaser is requested to form it for 40 hours more with the ordinary charging current used in working, which is at the rate of 0.026 ampère per square inch.

Mr. Capito tells us that, when he was at Millwall, such periods of formation as 120 hours were not used; and he thinks that this may be due to the fact that formerly the plates were not dried after pasting and before formation, as they are at present. This drying hardens the plates and produces a better cell; but he thinks that, as the paste is itself mixed with sulphuric acid, there is probably some sulphating of the negative plates during drying, and that several hours in the subsequent formation are probably spent in reducing this sulphate.

The reason, we understand, for the manufacturers only forming the positive plates for 18 hours, and leaving the purchaser to form them for the remaining 40 hours, is that if positive plates be *well formed* and then dried for carriage, the plugs become loose, which is not the case if the positive plates be only slightly formed before drying.

We were interested in learning from Mr. Capito whether, while superintending the manufacture of many thousands of accumulator plates, he had ever tried pasting the positive with lead peroxide (PbO_2) in order to avoid the necessity of having to form this salt electrically out of the red lead with which the positive plates are usually pasted. This idea of applying a paste of lead peroxide directly to the positive plate, he told us, he had tried, but that the method turned out a failure, from the impossibility of getting the lead peroxide paste to stick on to the grid even when some red lead was mixed with the lead peroxide. He also mentioned a very interesting fact—that whereas a paste of red lead mixed with dilute sulphuric acid of density 1.1 gives an adherent deposit on formation, on the contrary, a powdery deposit is produced if the density of the liquid used in making the red lead paste be 1.2. We understand the process that has shown itself the best is to use dilute sulphuric acid of density 1.1 for mixing the red lead paste, and dilute acid of 1.2 for mixing the litharge paste for the negative plates.

The Electrical Stock Market.

Mr. Erastus Wiman, at the Electric Club dinner last week, during the course of his remarks spoke of the difficulty of obtaining money on electrical securities. This subject is of such importance to the electrical business that it merits earnest consideration. Mr. Wiman undoubtedly referred in great measure to local electric light stocks and bonds. The prominent electric light stocks, while showing considerable fluctuation from time to time, cannot be placed in the class referred to. One reason these stocks and bonds are harder to secure money upon than other securities is because banks and trust companies are not thoroughly aware of their value and earning capacity, and have no one at hand to properly examine and report upon them. The fear of a competing company coming in and dividing the business in a town has a depreciating effect upon the price of the bonds covering the plant. Inferior construction work has also served to depreciate securities. There is no reason why an electrical bond is not as good a security as a gas or water bond; and if a corporation could be organized which would look upon the business of electrical securities in a thoroughly commercial light, having no special interest with any one electric light company, but with representatives from the leading companies in its directory, a desirable change and enhancement of electrical bonds would take place. Such a corporation could first find out the demand or necessity for an electric plant in the town proposing to build one. It could prevent in large measure ruinous competition at such towns by refusing to recommend a second issue of bonds to investors. This company could have its experts pass upon the proper construction of central stations, etc., make suggestions for economical management of plants and then underwrite or recommend the bonds. The leading companies would be likely to favor such an arrangement, as it permits healthy competition and appreciates the business as a whole, besides increasing the value of the vast amount of securities they have already on hand. A company of the kind mentioned with sufficient capital to carry on business properly would be eminently successful. The electrical business with $600,000,000 invested in it surely ought to be represented by a trust company and a bank as well. We would not then see good electrical bonds selling for 50 under forced sale if such a corporation existed conscientiously recommending good investments. The different trust companies and banks over the country would welcome such an institution, as they are in need of some source of information in regard to electrical bond investments, and such investments would receive more serious attention from them.

The condition of the financial market during the past week has not been very satisfactory. One of the developments has been the fact that people are hoarding gold. Gold has been disappearing for several months past. The sub-treasury reports that the gold coin in the sub-treasury has decreased from $128,000,000 in April to $107,000,000 in December. The Secretary of the Treasury has from time to time given an artificial turn to this condition by purchasing bonds, but the weekly bank statements have also shown heavy losses in gold, and it is already noted by good financial authority that for the past two months over $1,000,000 in gold has been lost weekly.

There must be some central point where values can be turned into cash and vice versa. Wall street is that point.

The laws of supply and demand are here found to govern as elsewhere. When the money market is tight there is necessarily an unloading of stocks. With an even or steady money market, the rise and fall is not so great, except in the case of individual stocks, which may go up or down as developments to their advancement or injury occur. The rise of stocks depends upon the demand for money. Business generally feels the depression of the money market, and many failures have occurred due to the impossibility of making collections. You may say, "If crops are good we should have prosperity." Well, that is so, if crops can be sold at fair prices.

For illustration of the present condition of affairs we will take the case of the cotton crop, which is the largest ever gathered. It is estimated at 7,500,000 bales. Cotton has declined about three cents a pound since last August. If the crop is sold now it means a loss of about $100,000,000 to the farmer. The Farmers' Alliance some time ago made an arrangement by which the farmer could store his cotton and get an advance on it with a very low rate of interest. Farmers are taking advantage of this offer and are endeavoring to hold off until the market price for cotton increases.

The Alliance arrangement can at best only be temporary, and the cotton must be sold before a great length of time elapses. The fact that cotton is not sold affects the country merchants, a large amount of the yearly business being due now. The country merchant is forced to ask favors of the jobber, and the jobber in turn appeals to the banks; and we find that even if we are blessed with good crops prosperity might not follow when money is very tight. The farmer cannot afford to raise cotton at the present market rate.

The foregoing statements are hardly pleasant to contemplate, and yet it is but proper to take account of them. On the other hand, we have the presidents of the largest banks in the East looking on the situation hopefully. The Bank of England has reduced its discount rate to five per cent., thereby showing a much better state of affairs in the London money market. The increased amount of money afloat with the first months of the year and also the possibility of the government purchasing a large amount of bonds furnish a much brighter side to the picture.

The electrical stock market has been very active this week, and, in many instances, shows great depression. It has reflected the action of the general market more perceptibly, taken as a whole, than at any time during the financial troubles.

Western Union has been selling off all the week, and closes at 74, which is four points below the last report. The stock has not suffered so greatly as some of the other stocks on the New York Exchange, but, in common with all the Gould stocks, has been inclined to weakness during the past week.

Edison stock closed at 70, which is quite a drop from last report. The sales of the stock have not been particularly active during the week, and the closing quotation does not really represent the true price of the stock. Stock sold on Saturday at 78, and the sale at 70 was forced. It would, therefore, be better to take the "asked" price rather than "bid" for present condition of Edison stock.

Bell Telephone stock closed at 199¼, which is 15¼ points lower than last week. This is an abnormal drop, but it must be remembered that the stock is ready to act on every rumor, and in this case simply echoes the general market. There are few chances for investment which can overtop Bell Telephone stock at 200 to 210.

Westinghouse stock closed at 16⅜, which is a fall from last week. The Westinghouse Company proposes to issue $3,000,000 of six per cent. preferred stock to provide cash for new business. The effect of this will be beneficial. An officer of the Westinghouse Company, referring to the question of the new preferred and deferred stock, is reported to have said that the preferred stock is entitled to a dividend of six per cent. in preference to the common stock, this dividend to be cumulative, and these shares to share equally in the profits when the dividends are more than six per cent. on both the common and preferred stock. As an illustration, say the earnings are 14 per cent., the preferred first gets six per cent., then the common gets six per cent., and the balance of two per cent. is equally divided between the two. Say 11 per cent. is earned, the preferred gets six and the common five; suppose, however, only five per cent. is earned, then the preferred gets the five, and the balance of the six guaranteed on the preferred is first taken from the next earnings, and the same distribution of the balance occurs. After the preferred gets to six per cent. all the balance of the earnings up to six per cent. goes to the common, and the excess is equally divided.

The closing quotations of electric stock, from F. Z. Maguire & Co., Electrical Securities, 18 Wall street, N. Y., Saturday, Dec. 6, 1890. New York, Boston and Washington. Pittsburgh closing Dec. 5.

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	74	74⅛
American Telegraph & Cable	100	14,000,000	83	85
Central and South American	100	5,000,000	155	165
Mexican	100	2,000,000	210	215
Commercial Cable Co	100	7,716,000	....	....
Postal Telegraph Cable	100	5,000,000	39	41
Edison General Electric Co	100	9,503,500	70	77
" " Deferred	100	2,496,500	....	....
Consolidated Electric Light	100	1,922 400	....	....
Edison Electric Illuminating Co.	100	2,567,800	68	70
United States Electric Light	100	1,500,000	30	....
North American Phonograph	100	6,200,000	30	35
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	39	39½
" " preferred	25	4,000,000	25½	26
" " Series C	10	400,000	...	12
" " Series D	10	120,000	5½	6
" International Co	100	350,000	....	....
Thomson Welding Co	100	1.000,000	....	200
" European Welding Co	100	1,500,000	....	60
Ft. Wayne Electric Co	25	4,000,000	10½	11
Telephone:				
American Bell	100	12.500,000	199¾	200
Erie	100	4,800,000	....	47
New England	100	10,304,600	...	49
Mexican	10	1,280,000	65c.	80c.
Tropical American	10	400,000	....	1¼
MISCELLANEOUS				
Edison Phonograph Doll	10	1,000,000	1¼	2
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	32
Chesapeake & Potomac	100	2,650,000	...	73
American Graphophone	10	600,000	11¼	12½
United States Electric Light (Washington)	100	300,000	139	145
Eckington and Soldiers' Home Electric Ry	50	352,000	57½	59¾
Georgetown and Tennallytown	50	200,000	47	55
PITTSBURGH.				
Westinghouse Electric Mfg. Co	50	5,000,000	16⅜	17½

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$298@$300	Cumberland	$ 59@ $60
Central Union	57@ 58	Wisconsin	118@ 120
Michigan	91@ 93	Bell of Missouri	155@ 160
Great Southern	32@ 35	Iowa Union	20@ 21
Colorado	38@ 40	Missouri and Kansas	55@ 57
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$85@$90	Chicago Edison Co	$128@$130

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-177 Times Building, New York, Dec. 8, 1890.

The Continental Dynamo Company has removed its offices from 63 Broadway to No. 45 Broadway (Aldrich Court), Room 135, and the business is now being conducted with Mr. W. D. Perry as general manager. The factory remains, as before, at Dover, N. J.

Suing a Telegraph Company.—The trial of a suit in which Mrs. Emily C. Berthet is plaintiff and the Mutual Telegraph Company defendant was begun in this city last week before Judge Lawrence and a jury in the Supreme Court. Mrs. Berthet wants damages of $5,150 from the company for not transferring to her two certificates, each for 100 shares of its capital stock. The defense, which is being made principally on behalf of the estate of John M. Rickins, is that she is not the owner of the certificates.

American Institute of Electrical Engineers.—The fifty-second meeting of the Institute will be held at 12 West Thirty-first street on Tuesday, Dec. 16, at 8 P. M. Mr. A. E. Kennelly will read a note on "Inductance in its Relation to its Proposed Unit, the 'Henry.'" "The Perfected Gramophone" will be exhibited at this meeting by its inventor, Mr. Emile Berliner, accompanied by experiments, illustrations and a full explanation. This will be the first public exhibition of this invention in New York City.

Lecture.—The one hundred and thirty-fourth meeting of the New York Electrical Society will be held in the lecture hall of the Mechanical Engineers, 12 West Thirty-first street, on Wednesday, Dec. 10, at 8 P. M. Mr. Edward P. Thompson, a well-known patent solicitor of this city, will deliver a lecture on "How to Make Great Inventions: or the Science and the Art of Inventing." Mr. Thompson will review the scope and tendency of modern invention, and point out how valuable an invention may be to the patentee and public alike, and how possible it is by systematic effort to make important improvements in every line of work.

Bids for Electric Lighting.—The Gas Commission met last week in the office of the Commissioner of Public Works and opened the electric light companies' bids for lighting the street lamps in 1891. The United States Illuminating Company asked 43 cents a night for each of 309 lamps, the Brush Company 43 cents a night for each of 137 lamps and 45 cents a lamp for each of 152 lamps, the East River Company 44½ cents a night for each of 247 lamps, the Mount Morris Company 43 cents a lamp for each of 171 lamps, the Harlem Lighting Company 43 cents a lamp for 192 lamps and 50 cents a lamp for each of 19 lamps in Mount Morris Park, and the North New York Company 50 cents a lamp for each of 28 lamps.

The Electric Club Dines.—Covers were laid for 75 at a dinner at the Electric Club rooms, 17 East Twenty-second street, last Thursday evening. After dinner Erastus Wiman spoke to the club on the wonders of electricity. Toasts were also responded to by Joseph Howard, Jr., E. Bunnell Phelps, and W. D. Howard. Mr. T. C. Martin delivered a short lecture on "The Fireflies and their Relation to Electricity," and Frank Z. Maguire played an original composition on the piano. Among those present were Capt. E. L. Zalinski, Capt. W. L. Candee, W. D. Sargent, George Worthingham, C. A. Price, Joseph Wetzler, C. E. Stump, F. W. Royce, C. O. Baker, Jr., P. H. Alexander, C. A. Hamilton, C. D. Shain Henry D. Stanley, J. H. McGraw, Charles W. Price and W. W. Stadler.

Electric Patent Litigation.—In the suit of the Brush Electric Company against the Sprague Electric Railway and Motor Company for alleged infringement of patent, the defendant company last week filed an answer in the office of the Clerk of the United States Circuit Court in this city. In this answer all the allegations in the bill of complaint are generally denied. It is also averred in the answer that the letters-patent granted to Charles F. Brush are void and of no effect, principally because the improvements or inventions claimed by him are described in previous letters-patent granted in this country and Great Britain, prior to his alleged invention; and because, it is asserted, Elihu Thomson, and not Brush, was the original inventor of the alleged improvements.

W. T. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 8, Cook Building, cor. Franklin and Congress Sts.
Boston, Dec. 6, 1890.

The Pettingell Andrews Company has shipped this week a number of orders to British Columbia, Honolulu, S. I., and Havana, Cuba.

The Voltaire Electric Shoe Company, of Manchester, N. H., with a capital of $50,000, has filed articles of incorporation at the Secretary of State's office.

City Electrician.—At a meeting of the Board of Aldermen in Lynn, Wednesday evening, Edward L. Hiller was re-elected city electrician for the coming year.

Beverly, Mass.—The selectmen last Saturday evening, by a vote of three to two, refused to grant the Naumkeag Street Railway permission to erect the overhead electric system.

The National Telephone Company is crowded with business, among the late installations are the Spencer Wire Company, Spencer, Mass., and several factories in New Bedford.

Mr. O. S. Platt, of Bridgeport, Conn., manufacturer of the well known New England switch, has just finished and has now ready for the market switches of from 75 to 100 ampères capacity.

City Inspector of Wires.—The appointment of B. S. Flanders to be inspector of wires, under the statute and ordinance recently passed, has been unanimously confirmed by the Boston Board of Aldermen.

East Bridgewater, Mass.—A manufacturer of electrical appliances has been looking over the buildings of the Brayton Petroleum Engine Company at East Bridgewater with a view to possible location.

Ayer, Mass.—The Ayer Electric Light Company, Dr. B. H. Hartwell, president, intends taking immediate steps toward putting in a system to comprise Ayer, Shirley and Groton, all Massachusetts towns.

New Whitman Electric Road.—The cars on the Whitman & Brockton (Mass.) electric road will be started about Dec. 1. The officials of the local company will celebrate the event with a public banquet and speechmaking.

The Tripp Manufacturing Company is shipping this week 14 trucks to Tacoma, 4 trucks to Seattle and 10 trucks to Sacramento. This company is rushed with business and will probably build a larger factory at an early date.

Holyoke, Mass.—The new electric power station of the Holyoke Water Company at Holyoke will be equipped for furnishing light and power on a very large scale. Four water wheels of 250 h.

p. each will be used. These will be interchangeable. There will be boilers to the amount of 1,500 h. p. Two 400 h. p. engines are to go in; besides these the company has a reserve force of another 350 h. p. engine.

Mr. C. E. Bibber has just returned from a business trip to the West for Holtzer Cabot & Co., and reports a very successful trip, especially so with their new "Volunteer" gas-lighting pendant, for which he has received some very large orders.

Electric Railway at Northbridge.—Articles of incorporation have been granted to the Whitinsville Street Railway Company to conduct an electric railway at Northbridge to extend to Whitins Station, a length of one and a half miles; capital, $20,000. J. M. Lasell is treasurer and W. E. Johnson clerk.

To Locate an Electric Power Plant.—The West Haven (Conn.) Horse Railroad Company has bought a piece of land in West Haven, with the intention of locating an electric power plant. The company's petition to the common council for permission to use the overhead trolley system has been signed by over 200 citizens.

Mr. H. C. Roberts, formerly general agent of the Connecticut Motor Company, is now a member of the firm of Vallee Bros & Co., of Philadelphia, who have gone into the business of electrical supplies and expect to have the largest exclusive supply house in that city. Mr. Roberts is at present in New England on a purchasing trip for his company.

Mr. S. E. Barton, of the Electric Mutual Insurance Company, Boston, is at present on a trip in the South, where he placed some magnificent risks among the electric plants. The business done by this company now runs into the millions of dollars, and the end of its growth is not yet by any means.

Pittsfield, Mass.—It is reported as a settled fact that a company will be incorporated under the name of the Stanley Electric Manufacturing Company to engage in the manufacture of certain specified electrical appliances. William Stanley, Jr., will, it is said, have charge of the plant. This is announced as the result of the work of the committee that was investigating Mr. Stanley's inventions.

The Star Electric Company, of Bridgeport, Conn., reports the following installations: One 500-light alternator for central station lighting for the town of New Milford, Conn.; one 75-light Chapman dynamo for the Eastern Upholstery Company, of New Milford; one 125-light Edison for the New England Pin Company, of Winsted, Conn., and one 75-light Chapman for the Adirondack Pulp and Paper Company, of Malone, N. Y.

The Consolidated Electric Company, of Boston, is at present very busy. Some 70 men are now employed and it is expected that by Jan. 1 there will be 100. Large orders for "H. G." key and keyless sockets are being received daily. The company's present prosperity is due largely to the wise and efficient business management of Mr. A. R. Brown, who in two years has brought the business from almost nothing to its present splendid showing.

No Talking to the Motor Man.—General Manager Monks of the West End Railway, Boston, has issued the following order to motor men on electric cars: "You are hereby notified that you must not hold conversation with any passenger while on duty on your car. If passengers wish to engage in conversation with you, tell them politely that you are not allowed to talk with them, as your time and attention must be fully occupied in the careful operation of the car."

Boston Board of Aldermen.—The order passed by the board Nov. 17 authorizing the Boston Electric Light Company to erect poles in Dorchester street and Columbus avenue was vetoed by the mayor The veto message states that the order was passed under a suspension of the rules, without public notice and that the people on Columbus avenue are almost unanimous in their objection to poles on the avenue. The remonstrants, the mayor says, are entitled to a hearing. The veto was sustained.

The Marlborough (Mass.) Street Railway Company is building an electric snow plow, which, when finished, will weigh 10 tons. It will be driven by two 15 h. p. Sprague motors. The designs were made by and the work is being carried on under the supervision of H. E. Bradford, the electrician and master mechanic of the road. The above road was started one year ago last June and has not missed a trip for any cause since. This is largely owing to the ability of Mr. Bradford, who, when the road was started, hardly knew what a motor was, but by hard study and the knowledge of practical mechanics speedily adapted himself to the new conditions.

The Electric Gas Lighting Company, of Boston, besides its large business in manufacturing gas lighting apparatus, electric supplies and other electrical novelties, is engaged in extensive designing and manufacturing of special work. It has now on exhibition at 195 Devonshire street two switchboards of 50 wires each, metallic circuit, with special extra listening connection for each circuit and extra ground wire connection for testing each circuit. These boards have also a new drop differing from all others now in the market. These boards will be placed in the chief engineer and fire alarm offices of Boston respectively. They are attracting great attention from fire alarm people throughout this section. Another novelty is the Star electro-mechanical gong, which strikes 300 strokes with one winding. Mr. T. W. Lane has charge of the factory, which is a guarantee of its excellent work.

The Standard Electric Time Company, of New Haven, Conn., has licensed the Standard Electric Time Company, of Seattle, which will control the territory of Washington and Oregon. This company has a paid up capital of $25,000 and has already bought a plant for Seattle, which will be put into operation immediately, and the company will also have plants in operation in Portland and Tacoma within a short time. The contracts oblige the company to have in operation 650 clocks inside of three years and matters will be pushed until both States are thoroughly covered. The parent company has recently installed a regulator and 21 clocks in the factory of Greene & Daniels, Pawtucket, R. I. Its business in isolated plants for factories, public buildings and railroad stations has increased in the last year so that it was larger than all former years combined, and the stockholders have voted to increase the capital stock $25,000 to provide available capital for the large increase.

No Consolidation.—The State board of gas and electric light commissioners of Massachusetts has dismissed the petition of the Worcester (Mass.) Gas Light Company for authority to engage in the electric lighting business. The company had arranged with the electric light company by an agreement, assented to by the stockholders of each company, that the former should purchase the latter's plant. The gas commissioners say, in effect, that such consolidation would not benefit the public. Each company has a good plant, and is earning good dividends. The commissioners do not see how the expense of producing either electric light or gas could be diminished by the consolidation, and they do see how the interests of light consumers might be unfavorably affected by such a monopoly as the petition contemplates. They say there is no city the size of Worcester in the country where lighting of both kinds is done by one company. L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY BUILDING, PHILADELPHIA, Dec. 6, 1890.

Mr. J. J. Gates, general manager of the Perkins Electric Lamp Company, of Manchester, Conn., was in the city last week on business.

Coatesville, Pa.—C. Ridgway & Son have shipped a 24-inch turbine wheel to Dublin, Ireland, to be used in operating an electric light plant for Lord Andelawn.

Christiana, Pa.—The Christiana Machine Company has sold over 10,000 iron pulleys this year, ranging from six inches to eight feet in diameter. A great part of them were shipped to the large electric light companies.

Alexander Bros. are making two large double leather dynamo belts, one being 26 inches wide, to be used in the electric light plant which Wm. Wood & Co. are putting in to illuminate their large mills at Twenty-second and Spring Garden streets.

The Heisler Electric Light Company has just installed the following plants: A 400-light plant at Monclova, Mexico; a 400-light plant at Hastings, Mich.; a 350-light plant at Waxahatchie, Tex.; a 300 light plant at Pensacola, Fla.; a 250-light plant at Oxford, Mich.

West Chester, Pa.—The West Chester Electric Street Railway Company met last week and awarded the contract for building one loop of its line, which measures 7,400 feet. The remainder will be given out in a few days. The company proposes to have its line in operation by the first of January.

Mr. J. W. Parker, of 38 South Fourth street, closed a contract last week with the Lock Haven, Pa., Electric Light Company for a 15 × 16 140 h. p. standard Ball engine and two 60 × 16 80 h. p. horizontal tubular boilers, pumps, heater and injector. He has also contracted to rebuild the old station. This engine will run a Thomson-Houston alternator of 1,300-light capacity, and an arc dynamo.

Messrs. Walker & Kepler report the following installations made during the past week: Wolstenholme, Harrigan & Clarke, yarn manufacturers, Kensington, one 135-light dynamo, with 15 h. p. automatic Westinghouse junior engine; Alfred A. Guigues, 929 North Third street, two dynamos, total capacity, 600 lights, with 15 h. p. automatic Westinghouse junior engine; Martin and Wm. H. Nixon Paper Company, Manayunk, one 325-light dynamo, with one 40 h. p. automatic Westinghouse standard engine.

The Thomson-Houston Electric Company reports the following sales made by the general department at Philadelphia: Franklin Electric Light Company, Franklin, Pa., 650 incandescents; Lewiston Electric Light Company, Lewiston, Pa., 1,000 incandescents; Riter & Conley, Allegheny, Pa., 30 arcs and 50 incandescents; Bloomsburg Electric Light Company, Bloomsburg, Pa., 50 arcs and 650 incandescents; Duquesne Iron Company, Pittsburgh, Pa., 35 arcs; Bradford Electric Light Company, Bradford, Pa., 1,300 incandescents; Edison Electric Illuminating Company, Easton, Pa., 50 arcs; Edison Electric Illuminating Company, Scranton, Pa., 50 arcs; McKeesport Electric Light Company, McKeesport, Pa., 50 arcs.

Overhead Wires.—The sub-committee of councils, which has under consideration the ordinance granting permission to the Passenger Railway Company to use the overhead electric system of rapid transit, met at Fifth and Chestnut streets last Thursday afternoon. All the councilmen from West Philadelphia and other gentlemen who are interested in the matter had been invited to be present, and as a result the meeting was crowded. W. S. Kimball, who is interested in real estate in that section of the city, Representative W. S. Kinney, Councilmen Thomas and Hall and others favored the project. The latter offered an amendment to the effect that should an elevated road be built on Market street the wires should be strung from the elevated structure instead of from poles, as proposed by the ordinance. The amendment was adopted after Councilman J. M. West, who said he was opposed to the adoption of the overhead system, had refused to say anything further upon the subject, and the ordinance was referred to council with a favorable recommendation.

New Isolated Plants.—The Thomson-Houston Electric Company has recently installed the following isolated plants through Mr. C. K. Westbrook, who is manager of that department: Williamsport & Chesapeake Lumber Company, Williamsport, Pa., 30 arcs; Harlan & Hollingsworth, Wilmington, Del., 1,200 incandescents; A. Jewett & Co., 924 Noble street, Philadelphia, Pa., 50 incandescents; Geo. W. Stone, Wilmington, Del., 150 incandescents; A. J. Brumbach, 150 incandescents; Antietam Paper Company, Hagerstown, Pa., 50 incandescents; Beech Creek Railroad Company, Jersey Shore, Pa., 20 arcs; Wilson Female College, Chambersburg, Pa., 150 incandescents; Galena Oil Works, Franklin, Pa, 150 incandescents; Hale & Kilburn Manufacturing Company, Philadelphia, Pa., 30 arcs; Stearns Manufacturing Company, Erie, Pa., 30 arcs; Pennsylvania Iron Works, Philadelphia, Pa., 12 arcs; Pennsylvania Steel Company, Sparrow's Point, Pa., 600 alternating: Muehling & Johnson, Stroudsburg, Pa., 100 incandescents; Warden Apartment House, Philadelphia, Pa., 1,600 incandescents; Pulaski Iron Company, Pulaski, Va., 20 arcs; J. S. Thorne, Philadelphia, Pa., 10 arcs. W. F. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Dec. 6, 1890.

W. W. Griscom, president of the Electro-Dynamic Company, Philadelphia, is one of the welcome visitors in Chicago this week.

Force Bain, of 84 Market street, Chicago, is preparing to place on the market a motor of exceedingly simple construction, high efficiency, and low cost.

Frederick L. Merrill, of Chicago, formerly with the Johnston Electric Train Signal Company, is now connected with the Great Western Electric Supply Company.

The Day Electrical Company has been incorporated in Illinois to control patents for electrical machines; capital stock, $100,000; incorporators, St. John V. Day, W. T. Block and G. H. Simmonds.

The Morgan Park Electric Company has been incorporated at Chicago to furnish electric light, power and heat; capital stock, $25,000; incorporators, F. S. Wheaton, George A. Meech and J. H. Westovers.

The Electrical Machine Company at Chicago has been incorporated to deal in electrical machines and appliances; capital stock, $5,000; incorporators, Everett S. Tomlinson, Henry A. Caldwell and John F. Flannery.

Mr. G. L. Thayer, of Chicago, is taking a course as an electrical engineer at Cornell. Mr. Thayer is the son of George H. Thayer, superintendent of telegraphs for the Chicago & Northwestern Railroad Company.

New Storage and Power Company.—The New Electric Storage and Power Company, Chicago, has been incorporated with a capital stock of $250,000, to manufacture electric appliances and furnish electric currents for power and illumination; incorporators, John E. Wiles, J. A. Sharp, J. B. Hogue.

Patent Litigation.—Charles Lieb, of New York, has entered a suit against the Electric Merchandise Company, and W. R. Mason, of Chicago, for infringement of patent No. 434,087 for improvement in electric conductors.

New Fixture Company.—The Chicago Gas and Electric Fixture Manufacturing Company has been incorporated at Chicago, with a capital stock of $50,000; incorporators, Henry G. Willard, Larsen Filstrup, Edward Baggott and Thomas W. Wilmarth.

The Fuller Watchman's Electrical Detector Company (Chicago) have been incorporated to manufacture electrical machinery and appliances with a capital stock of $200,000; incorporators, Isham D. Fuller, William D. Carlisle and E. S. Bottum.

An L Road with Electric Power.—An elevated railroad with electric motive power is contemplated for Milwaukee avenue, Chicago. Its projectors are D. V. Purington and ex-Alderman Kerr, the capital stock of the company being placed at $5,000,000. It is understood that the company has already secured enough frontage for a track five miles long. Its projectors, however, refuse to disclose their plans before appearing before the council.

Marquette, Mich.—The experimental station erected by Thomas A. Edison at Humboldt, 30 miles west of Marquette, for the purpose of concentrating low-grade iron ores by electricity, was destroyed by fire the 3d inst. The fire began in the engine house. The building was valued at about $7,000 and contained two dynamos and much valuable machinery, all of which is ruined, making the total loss not less than $12,000. There was $5,000 insurance. The station was established two years ago.

New Home for Electrical Mechanics.—The Brotherhood of Electrical Mechanics opened its new quarters at 91 Dearborn street, Chicago, last week. The first of the winter series of lectures on electricity was delivered by Prof. Atkinson, who talked in an informal way, illustrating the subject by a liberal use of colored charts. The newly elected officers of the brotherhood are: Charles Z. Quealy, president; C. E. Stone, vice-president; H. M. Hawley, secretary, and O. P. Selles, treasurer.

Recent Sales.—The railway department of the Thomson-Houston Electric Company, at Chicago, is doing an active business in the sale of that company's perfecting snow sweepers, having taken orders for something like a dozen of them during the last few weeks. The same department also reports the sale of 15 additional cars and electrical equipment, including generators and overhead construction for 10 miles of track, to the San Antonio Street Railway Company, San Antonio, Tex.

MINNEAPOLIS, Dec. 5, 1890.

The Medicine Lake Electric Railway enterprise has been capitalized at $50,000. Mayor-elect P. B. Winston is one of the stockholders.

Electrical Expert.—John M. Lannon, an electrical expert from London, England, has opened an office at 22 Loan and Trust Building, Minneapolis, and is fitting it up with a display of the electrical supplies for which he is manufacturer's agent.

Half Way to St. Paul.—The inter-urban line of the Minneapolis Street Railway Company is now in operation as far as Prospect Park, though the regular motors to be used on this line are not yet ready. There are 40 of these cars, and their capacity is 25 miles per hour drawing two "trailers." The line will not be ready for regular traffic between Minneapolis and St. Paul before Dec. 15.

A disastrous fire at Eau Claire, Wis., on the morning of Dec. 1, destroyed the fine plant of the Eau Claire Electric Company, inflicting a loss of $20,000 and shutting off the incandescent and arc lamps for the entire city, as well as shutting down the street railway system. The fire came at an unfortunate time for this new company, which had in contemplation very extensive improvents in its street railway.

A Fight in the Courts Promised.—The Western Union Telegraph Company does not seem at all disposed to obey the direction of the city governments of Minneapolis and St. Paul in the matter of burying its wires. Superintendent McMichael, of that company, has offered to place the wires in cables as they have done in other cities, but this method of compromise has been rejected and ordinances passed requiring the wires to be laid in underground conduits.

C. D. Brown, of Minneapolis, has received a caveat from the patent office at Washington, securing to him valuable patents on an appliance for cutting off the electric currents on all kinds of wires as soon as a break occurs, thus preventing the possibility of death from this cause. The same electrician is the inventor of a trolley attachment for maintaining the connection with the motor when the trolley wheel jumps off the wire. The Minneapolis Street Railway Company will test both of these appliances, and be the first to adopt them if their operation is successful. H. C. E.

SOUTHERN NOTES.

NORFOLK, Va., Dec. 6, 1890.

Louisville, Ky.—An isolated electric light plant has been installed in the Tarascon Woolen Mills.

Titusville, Fla.—The Titusville Electric Light Company has been incorporated, and will erect a light plant.

Sumter, S. C.—New machinery is to be shortly added to the electric light plant of the Sumter Electric Light Company.

Henderson, Ky.—The city council is obtaining estimates of the cost of an electric light plant, and one will be established.

Memphis, Tenn.—An electric light installation will be added to the plant of the Empire Elevator, Mill and Warehouse Company.

Savannah, Ga.—Additional machinery will be added to the electric light plant of the Brush Electric Light and Power Company.

Weldon, N. C.—The city council are negotiating with an electric light company for the establishment of an electric light plant.

Hagerstown, Md.—The capacity of the electric light plant of the Hagerstown Electric Company is being enlarged by the addition of more machinery.

Northport, Ala.—The city council is preparing a petition to the State Legislature for the privilege of issuing bonds to establish electric lights and effect other improvements.

Chattanooga, Tenn.—It is stated that the Thomson-Houston Electric Company, of Boston, Mass., will establish an electric light and power plant 150×200 feet. A site for the plant has already been secured.

Ashville, Ala.—An electric light plant will be established by a company recently organized, and which has awarded a contract for the erection of the plant to the Western Electric Company, of Chicago, Ill.

A Bee-Hive plant is to be erected at Anniston, Ala., and to be supplied with electric power for the establishment of a number

of small industries. F. P. Heifner has been awarded the contract for the erection of the building.

Crisfield, Md.—The Crisfield Electric Light Company has been recently organized, with $10,000 capital stock, to establish an electric light plant. G. F. Atkinson is president, F. H. Coulboum, vice-president; L. E. P. Dennis, secretary.

Will Make Electrical Machinery.—The Donaldson-McRae Electric Company has been incorporated at Baltimore, Md., with a capital stock of $20,000. W. W. Donaldson, Roderick McRae, A. H. Robertson and others are the incorporators. The purposes of the company are to manufacture electrical machinery.

V. N. B.

ENGLISH NOTES.

(From our own Correspondent.)

LONDON, Nov. 26, 1890.

Newcastle.—The junction boxes of this town are evidently bent on emulating the performances of their *confrères* across the Atlantic, the lids of three of them having been blown off during the last fortnight.

The National Telephone Company.—Mr. A. R. Bennett, the late general manager of the northern district of the National Telephone Company's territory, has just resigned that appointment and accepted the post of general manager and chief engineer to the Mutual Telephone Company, which, as some of your readers may perhaps recollect, proposes as soon as the more important telephone patents expire, to enter into aggressive competition with the National Company.

The Electric Construction Corporation.—This company, as I cabled you recently, has announced a dividend of 6 per cent. per annum, and its balance sheet is now to hand. With a working capital of £500,000, its turn over for the past year amounted in round numbers to £250,000. Of this the cost of production absorbed £173,000; and office expenses some £15,000, and after writing off various amounts for patents, etc., and placing £15,000 to the reserve fund, sufficient remained to give the shareholders a dividend of 6 per cent. This balance sheet is, for this country, a very satisfactory one.

Overhead Wires in London.—The London County Council proposes to reintroduce its bill of last session dealing with overhead wires. Since practically all the electric lighting of London is now carried out under statutory powers, overhead electric light wires are almost things of the past. The scope of the bill is, therefore, narrowed to dealing with telephone wires, and as the bill seems rather to encourage these, provided they are absolutely necessary, it does not appear as if it will have any appreciable effect on the numbers of wires at present in existence in London, though it may possibly result in the hauling down of a few derelict conductors.

The Institution of Electrical Engineers.—On Wednesday last the president of the Institution of Electrical Engineers, Dr. John Hopkinson, F. R. S., gave a well attended "conversazione" in the galleries of the Royal Institute of Painters in Water Colors. So large was the attendance that an extra hall had to be hired, but for which the crush would have been unbearable. On the following day the second annual dinner of the institution was held at the Criterion restaurant, over 150 being present. Perhaps the most interesting speech of the evening was that of the Attorney General-Sir Richard Webster, M. P., whose name has figured pretty prominently in electrical patent cases during the past ten years. Sir Richard, who is no mean electrician, but who persists in asserting that he knows nothing about the subject, has, I may say, been elected a member of the institution.

News of the Week.

THE TELEGRAPH.

The Bankers' and Merchants' Company Sold.—A deed was recorded at Washington last week, by which W. N. Armstrong, of New York, as referee, conveyed, for a consideration of $390,000, to John W. Mackey, of Virginia City, Nev., all the rights, franchises and privileges of the Bankers' and Merchants' Telegraph Company, the Bankers' and Merchants' Telegraph Company of New Jersey, the Bankers' and Merchants' Telegraph Company of Pennsylvania and the Bankers' and Merchants' Telegraph Company of Indiana, including the lines of the company from Washington to New York.

President Harrison, in his message to Congress says on the subject of Government ownership of telegraph lines: "The use of the telegraph by the Post-office Department as a means for the rapid transmission of written communications is, I believe, upon proper terms quite desirable. The government does not own or operate the railroads, and it should not, I think, own or operate the telegraph lines. It does, however, seem to be quite practicable for the government to contract with the telegraph companies, as it does with the railroad companies, to carry at specified rates such communications as the senders may designate for this method of transmission. I recommend that such legislation be enacted as will enable the Post-office Department fairly to test by experiment the advantages of such a use of the telegraph."

Receiver for the B. & O. Telegraph Company.—The Interstate Telegraph Company has filed a bill in the United States Circuit Court at Baltimore against the Baltimore & Ohio Railroad and the Baltimore & Ohio Telegraph Company. The bill alleges that the complainant recovered recently a judgment against the Baltimore & Ohio Telegraph Company for $25,000 and costs, which it has been unable to collect, and prays for a receiver for the Baltimore & Ohio Telegraph Company, and that the railroad may be required to account to the creditors of the telegraph company for so much of the $4,000,000 received by it from the Western Union Telegraph Company as may be necessary to satisfy the claims of the complainant and all other creditors who may come into the case.

The Government and Western Union.—The San Francisco *Call* says that a complaint was filed in the United States Circuit Court in that city last week by the Government of the United States, through Attorney-General Miller and Special Assistant Charles H. Marvin, of Chicago, against the Southern Pacific Railroad Company, the Central Pacific Railroad Company and the Western Union Telegraph Company. The object of the complaint is among other things to secure the cancellation of the lease of the Central Pacific's telegraph lines to the Western Union Telegraph Company. In addition to the cancellation of the lease, the complaint demands that the lines referred to be operated and maintained separately and independently in accordance with the original agreement between the corporations and the Government.

Laying of a New Cable.—A telegram from Valparaiso, Chili, dated Dec. 1, says: "The cable steamer 'Silvertown' arrived here yesterday from London, having on board the submarine cable to be laid between Callao, Peru, and Valparaiso, Chili, for the Central and South American Telegraph Company, of New York. Sounding will be taken on the northward trip, and when completed the cable will be laid from Callao to Iquique, thence to this city. Its opening about Jan. 1 will be followed by a reduction in commercial and press rates to all places in Chili and Argentine. Many of the objectionable restrictions, such as double charge for code messages and a fee for registration imposed by the English companies, will not be enforced by the American company. The Central and South American Cable Company is making arrangements for the construction of a land line for the use of the cable company between Valparaiso and Buenos Ayres.

THE TELEPHONE.

Danvers to Lose its Telephone Service.—The New England Telephone Company have served a notice on their subscribers in Danvers, Mass., that on Dec. 18 telephone service in the town will be discontinued. They have also notified the town to remove all electric light wires from their poles. It is understood that this action is taken because the town will not grant rights for poles as now set, the law now requiring written permission.

THE ELECTRIC LIGHT.

Springfield, Mass.—The new Corliss engine has arrived for the united electric light plant at Springfield. It is the largest in that part of New England, the capacity being 800 h. p.

The Home Electric Light and Power Company has been incorporated in Illinois to furnish light, heat and power; capital stock, $25,000; incorporators, Carl Brand, Fred Kelly and others.

Gardiner, Me.—There is talk in Gardiner of establishing an independent electric light and power plant, to furnish power for a new mill and electric lights for the extensive saw mill of H. W. Jewett & Co.

Lights for a Government Building.—The new custom house and post office building at Pittsburgh, now nearing completion, is to be illuminated by electricity, as a matter of course. The secretary of the treasury has recommended the appropriation of $15,000 for that purpose.

Mr. W. R. Caulkins, resident agent at Cleveland, O., of the Central Thomson-Houston Company, has just closed a contract with Cleveland parties for the installation of 100 arcs and 650 alternating incandescents, to be installed at Elyria, O. The Thomson-Houston apparatus will be used.

Plainfield, N. J.—The Plainfield Gas Light Company has practically completed the purchase of the plant of the Plainfield Electric Light Company, and in future will monopolize the public and private illumination of that city. The electric light company has just been given by ordinance the right to maintain as many poles and string as much wire as it desires through the streets for the next 10 years.

Recent Sales.—Mr. J. W. Johnson, of the western isolated lighting department of the Thomson-Houston Electric Company, reports the following recent sales of isolated lighting plants: St. Louis Railroad Company, power house and car barns, St. Louis, Mo., 400-light incandescent plant; and G. F. Culmer & Bros., Salt Lake City, Utah, 100-light incandescent dynamo, to be used in connection with a plant for lighting office building, sold some months ago.

A New Incandescent Plant.—A company is to develop the water power at Kelley's Falls, on the Piscatahuog River, at Manchester, N. H., for the purpose of operating a new electric light plant, to be devoted entirely to incandescent lighting. A 12-foot dam has been built and two large Rodney-Hunt turbine wheels have been put in, leaving room for two more. An effort will be made to bring new industries to the section to be supplied with electric power.

Electric Light in Public Buildings.—Supervising Architect Windrim, in his annual report to the Secretary of the Treasury, says that the advance made in lighting buildings by electricity has so thoroughly established the convenience and superiority of electric light that modern structures are incomplete without the system, and it has become a necessary equipment in the completion of a public building. The Supervising Architect recommends that a separate appropriation be made for placing electric wires in new public buildings, and that $125,000 be appropriated for electric wires in buildings now in construction.

November Business.—The Westinghouse Electric and Manufacturing Company completed during November a month of business which has been one of the largest in the history of that corporation. The company shipped an aggregate of incandescent alternating current light machines of 30,000 16-candle power lamp capacity. Among the places where the Westinghouse system has been installed are Philadelphia, Pa., 750 incandescent and 300 arc lamps; South Omaha, 750 lights; Ballston, N. Y., 750 lights; Lima, O., 1,500; Aspen, Colo., 750; Wellsburg, W. Va., 500 incandescent and 25 arc; Charleston, W. Va., 750, increase; Portland, Ore., 100 arcs.

A Durable Arc Lamp.—The Concord (N. H.) Electric Light Company recently took down a Thomson-Houston arc lamp which had received no repairs since it was hung, over four years ago, and aside from being quite dusty it appeared in as good condition as when put in. This company has recently completely overhauled and changed its circuits preparatory to carrying them into the new station. The new station will be one of the finest in the State, and fitted with Thomson-Houston Electric Company's generators for arc and incandescent lights and power, fully equipped with lightning arresters, slate switchboards, etc. The steam plant will be of more than 250 h. p. capacity, make and style not yet decided upon. The chimney is the tallest in the city and the handsomest in the State.

Removal of the Heisler Company.—The proprietors of the Heisler system of long-distance series incandescent electric lighting have found it necessary to transfer the manufacturing of their apparatus from St. Louis to their new and commodious works located at Gloucester, N. J., where, with enlarged space at their command and increased facilities, they will be enabled in the future to meet the constantly increasing demand for their apparatus. The extensive introduction and adoption of this system within the past two years for commercial, street and alley lighting has made it necessary to increase the manufacturing facilities. The company continues a St. Louis agency, where there will be kept on hand a supply of lamps and material for repairs, as well as emergency experts, whose duty it will be to look after the various installations west of the Mississippi River.

Prices for Arc Lighting.—The Thomson-Houston Electric Company has just distributed a very neat pamphlet giving the cities of the United States having contracts for street lighting by electricity, showing the conditions of the contracts and the price per annum. It furnishes a great deal of information that will be interesting to the central station man and to the electrical engineer. As might be expected it shows an enormous variation in the price of arc lighting. The highest price recorded is in Virginia City, Nev., where six 2,000 c. p. lights burning all night and every night are furnished at an annual price of $300 each. Low water mark in price appears to be in a little town in Massachusetts where 2,000 c. p. lights are furnished from sundown to half past twelve o'clock at an annual rental of $33.00. Altogether it forms a very convenient hand-book for reference in considering electric lighting.

Decision Regarding the Brush Lamp Patent.—In the case of the Brush Electric Company *vs.* The Western Electric Light and Power Company, in the Circuit Court of the United States for the Northern District of Ohio, it has been decided that letters patent No. 219,208, to Charles F. Brush for an electric lamp, are valid, and cover all forms of mechanism constructed to separate two or more pairs or sets of carbons dissimultaneously or successively, so that the light is established between the members of but one pair or set at a time, while the members of the remaining pair are kept separate. The word "dissimultaneous," used in his claims, refers to that separation which results in the production of a single arc. This patent is infringed by patent No. 418,758, to Charles E. Scribner for an electric arc lamp, notwithstanding that the primary or initial separation of the two pairs of carbons in the Scribner lamp is simultaneous.

Increase of Westinghouse Company's Capital.—The following statement was given out on the evening of Dec. 3 by the officials of the Westingbouse company: "The directors of the Westinghouse Electric and Manufacturing Company have held several important meetings with reference to the company's affairs, and particularly with reference to devising some means for putting the operations of the company on a cash basis, the floating debt and the increasing business of the company being the only obstacles to a high value for the company's shares. The difficulty in raising new money for carrying on the increasing business of the company and carrying loans has, owing to the stringency in the money market, been very considerable, and it was finally decided after a long discussion that the only practical manner in which to provide for the wants of the company is to exercise the power conferred by its charter of issuing preferred shares, and a meeting of the stockholders has been called for that purpose. A proposition will be submitted to the stockholders to authorize the directors to issue the remaining $2,000,000 of authorized increase, and to convert a total of $3,000,000 of the $10,000,000 into preferred stock to be entitled to a dividend of six per cent. in preference to the common stock, and this dividend to be accumulative; and these shares to share equally in the profits when the dividends are more than six per cent. on both the common and preferred stock. The management expect to have subscriptions complete by the time of the meeting to enable the company to carry on its business in a comfortable manner. The recommendation to create preferred stock was adopted unanimously after full discussion and after consultation with parties having a considerable interest in the company. It is believed that these shares will find a ready market as soon as people are in position to make investments, and that the extinguishment of the debt of the company by the issue of the preferred shares wil at once advance all of the shares of the company to the position which they should occupy by reason of the very large business which the company is doing. These preferred shares are to be sold at par and it is proposed to have the interest payable in July and January." A meeting of the stockholders of the company to vote upon the questions referred to in the above statement was called for Dec. 10, 1890.

APPLICATIONS OF POWER.

Calumet, Ill.—The Calumet Electric Street Railway Company, of Chicago, filed a certificate of increase of capital stock to $500,000.

La Porte, Ind.—The City Council has granted the right of way and franchise for an electric street car line in that city to Snow & Avery, of Detroit, Mich.

Street Railway Franchise.—The Clinton City, Ia., Council has passed an ordinance granting the Baldwin Electric Street Car company an exclusive franchise for five years.

The Morgan Gardner Electric Company has been incorporated at Chicago, with a capital stock of $100,000, to manufacture electric mining machinery and other devices. Incorporators, Henry A. Gardner, James P. Gardner, George C. Gardner.

Meriden, Conn.—The double wire system for the electric road in that city is to be removed and the Daft Company will put in the single wire system. The work of tearing down the old wires will probably be begun Tuesday with some 40 men at work.

An electric road from Thomaston, Me., to Camden is projected. The capitalists interested are the ones who built the electric railroad from Hallowell to Augusta. They have looked over the proposed route very carefully, and are pleased.

Aurora, Ill.—A movement is on foot in Aurora to build about five miles of street railroad, to be operated by the electric storage battery system. Twelve miles of railroad, to be operated by the overhead electric system, are now being constructed by another company.

Railway Patent Suit.—In the suit of E. W. Siemens against Stephen D. Field, David Dudley Field, and the Electric Railway Company of the United States, there was filed last week in the office of the clerk of the United States Circuit Court a stipulation extending the time for taking testimony to Feb. 1, 1891.

Electric Roads for Lowell.—The Lowell (Mass.) Horse Railroad Company and the Lowell & Dracut Street Railway Company have been given permission by resolution passed by Board of Aldermen to use electricity as a motive power. The companies will use the single trolley overhead system and expend about $475,000 in alterations, constructing of power house, etc.

The Love Electric Traction Company has been organized in Chicago to purchase, own and deal in patents pertaining to electricity; to manufacture, buy, sell and lease appliances for the arc light and utilization of electricity; to license and collect royalties from railroads when built under patents owned or to be owned by this company. Capital stock, $10,000,000. Incorporators, John C. Love, Homer N. Hibbard and Albert G. Wheeler.

The Troy Hill Electric Railway, which is to mount to the summit of one of Allegheny City's highest elevations, is being constructed with all possible haste. The poles are now being set, and the rails for the track, which are to come from the Cambria Iron Company, Johnstown, Pa., will soon be on hand. The people of Troy Hill are hoping to enjoy the advantage of electric locomotion by the middle of January of the coming year at the latest.

An Electric Road at Hammond, Ill.—Application has been made to the Illinois Secretary of State for articles of incorporation for the Hammond, East Chicago, and Whiting Street Railway Company. The incorporators will be Theodore M. Foote, Charles Huntoon and Frank Weeks. The capital stock will be $100,000. This company, which is composed of Hammond and Chicago capitalists, is about to build an electric line connecting the towns in the Calumet basin.

Running the Works with a Locomotive.—The Edison General Electric Company has been putting in a new battery o-

boilers at its Schenectady works. This necessitated some temporary device for furnishing the immense works with steam. Superintendent Turner went to Albany and contracted with Superintendent Hammond of the Delaware & Hudson Railroad for a locomotive, which has been placed in the yard of the Edison Works, and steam pipes are now run from the locomotive to the main steam pipes leading to the company's engines.

PERSONALS.

Mr. Charles A. Schieren has been elected president of the Young Republican Club of Brooklyn.

Mr. Cyrus W. Field celebrated his golden wedding in this city on Tuesday of last week. Congratulations were received from all over the world. Mr. Field is now 71 years of age, and has been a resident of New York City for 55 years.

Mr. George A. McKinlock and Miss Marion Rappleye were married by Bishop Cheney, Dec. 2, at the bride's residence, 3636 Prairie avenue, Chicago, and left for New York on the North Shore Limited, from which point they sailed for Europe on the "Etruria." Modest and retiring as ever, Mr. McKinlock kept the secret so well that none but the immediate friends were aware of the event, and the ceremony was witnessed only by close relatives. Among the wedding presents was an elegant silver service of about one hundred pieces with the cards of Mr. Durant Cheever, Captain W. L. Candee and George Manson attached. May health, happiness and prosperity accompany them through life.

MISCELLANEOUS NOTES.

Electrical Engineering at Princeton, N. J.—The school of electrical engineering is fast becoming one of the most important departments of the university. It was founded last year, and will graduate its first class next June. The present attendance, all of whom are college graduates, is: Seniors, two; juniors, eight; total, 10. Twenty-seven students of different classes are pursuing studies with the intention of becoming candidates for the degree of electrical engineer.

Naval Electricians.—The Secretary of the Navy in his annual report speaks of the introduction of electrical experts into the service as follows: "The extensive employment of electricity in its applications on shipboard makes it necessary for naval officers to acquire a certain amount of electrical knowledge. It is suggested that a corps of naval electricians be established in the different states that have created a naval militia, to be attached to this militia and to receive the naval training which it is the great object of the militia to give. By this means a corps of electrical specialists would be organized familiar with the needs and usages of the naval service."

Industrial and Trade Notes.

The Novelty Electric Company, of Philadelphia, has something novel and very attractive in the way of annunciators and burglar alarms and in a variety of styles.

The Globe Electric Cordage Works, Philadelphia, are shipping goods to Cuba as well as all parts of the United States. Their Oehrle flexible cord in fast colors is in great demand.

The North American Phonograph Company has made a five year contract with the Consolidated Electric Storage Company for the exclusive use of the accumulators of that company for phonograph work throughout the United States.

The Flegal Car Works, Long Island, N. Y., built all the handsome cars now running in Newark, N. J. They are 32 feet long, and carry a large number of passengers; they are constructed for strength combined with light weight and fine appearance.

Chandler & Littlefield, Room 40, Marine Building, Chicago, have secured the western agency for the T M. Foote speed regulator, which was illustrated in THE ELECTRICAL WORLD of Oct. 25. They are also manufacturers' agents for a varied line of machinists' and engineers' supplies.

Wm. H. Weston & Co., consulting electricians and contractors of Philadelphia, are driven with business to such an extent that they are obliged to seek larger quarters. They make a specialty of the design and manufacture of general and special electrical instruments and apparatus, stage regulators, rheostats, switches, etc.

Wheeler & Tappan, South Jefferson street, Chicago, are sending out a new illustrated descriptive catalogue of steam pumps and other machinery, which contains much data of value to steam engineers and to steam plant contractors. They make a specialty of standard steam pumps for feeding boilers and for various other purposes.

Mr. A. C. Kemper, at 208-210 Lake street, Chicago, general Western agent for the Magnesia Sectional Covering Company, has in his possession several remarkably fine unsolicited testimonials, recording the merits of magnesia covering. Among the most prominent users may be mentioned the Chicago Board of Trade, Chicago Edison Company and the Illinois Steel Company.

The Electrical Supply Company, 171 Randolph street, Chicago, has lately placed upon the market the Bassett combination portable and bracket lamp support. This article is, as its name implies, a combination of both a portable and bracket, and as it is moderate in price will probably meet with large sales. This article is described and illustrated in another column, and will probably meet all requirements where it has been necessary before to use separate articles.

W. H. Gordon & Co., 115 Broadway, this city, have taken the general selling agency for the Star Electrix Company's switches, sockets, cut-outs, etc., and are prepared to quote prices to dealers and consumers. The business of this firm has increased wonderfully within the last year, owing largely to its energy and promptness in filling orders. Mr. Gordon recently spent a week in the West, where he made some large sales of simplex wire, for which he is the New York agent.

The National Electric Manufacturing Company, Eau Claire, Wis., has issued a handsomely illustrated description of its direct-current incandescent system, which has been put upon the market to supply the demand for an improved form of such machines, resulting from the uniform success which has attended the introduction of its transformer system of incandescent lighting. Included in this catalogue are a number of wiring tables that are of value to every one installing electric light apparatus.

Mr. A. B. Laurence, of the New York office of the Shultz Belting Company, reports among his recent sales that of six 12-inch of the Shultz patent fulled leather belting to the American Express Company, Hudson street, this city; four 10-inch for Lakewood Hotel, Lakewood, N. J.; two 10-inch for the Deutsche Verein Club, this city; four 12 inch for the new Music Hall, this city; one 12-inch for the Chelsea Jute Mills, Brooklyn, and one 12-inch for the Laboratory of Thos. A. Edison. This is the third order for Mr. Edison's laboratory.

The Universal Arc Lamp Company, 16 and 18 Broad street, this city, has just finished a thorough test of 12 of its new style arc lamps, the test being made in the presence of a number of electrical experts, who pronounced it eminently satisfactory. The test was made with two lamps in series across circuits of 100, 105, 110, 115, 120 volts difference of potential, each pair of lamps requiring eight to nine ampères. The light produced was said to be very steady and brilliant, the half-inch carbon burning without hissing or causing the lamp to flicker.

Thomas Wrigley, of 85 Fifth avenue, Chicago, has recently placed one of the vertically adjustable dynamo supports under a 50-light Thomson-Houston dynamo weighing 5,000 pounds in the central station of the Chicago Arc Light and Power Company. It is in very successful operation, one man raising or lowering the dynamo with the greatest ease. Nine of these supports are in use in the City electric station, corner of West Van Buren and Throop streets, and are giving excellent satisfaction. Mr. Wrigley will shortly place these on the market.

"Canvas Jacket."—The Illinois Electric Material Company is meeting with excellent success in introducing its "Canvas Jacket" moisture and fire-proof woven insulation. During a recent test of various insulations it was reported that "Canvas Jacket" gave better results in the matter of fire and moisture proof than any other insulation tested. The company claims that its insulation has an added tensile strength over any other form of covering, on the principle that a piece of woven canvas or sail cloth will wear longer than a knit of braided cloth of the same weight.

The Lewis & Fowler Manufacturing Company, Brooklyn, N. Y., builders of street railway cars for electric motors, has been very successful in the introduction of its cars among electric railway companies. Its cars on the Coney Island & Brooklyn Electric Railway system are running most successfully, and, it is said, they are to be adopted on several other electric roads contemplated in Brooklyn, as well as throughout the country. This company also manufactures all kinds of street car equipments and trucks. Its catalogue contains a detailed description of its numerous specialties.

The John Stephenson Company, Limited, this city, is said to be the oldest builder of railway cars in this country. It has built street cars for electric railways for many cities in the United States, and many have gone abroad. Its cars on the Fourth Avenue Electric Railway in this city, using the Julien storage batteries, are models of excellent construction. This company builds cars from designs furnished, and will prepare special designs to order. Enough designs of cars to satisfy the most fastidious taste are carried in stock. The company has its own motor trucks, which were illustrated in THE ELECTRICAL WORLD a short time ago.

Rawhide Pinions.—The Electric Merchandise Company of Chicago has supplied about 75 electric railways with its rawhide gears. The company has received the following commendatory letter from Mr. E. G. Connette, the superintendent of the United Electric Railway, of Nashville, Tenn.: "We have used your rawhide pinions and are very well satisfied with them. While the life of a rawhide pinion is not quite so long as a good bronze pinion, the saving on the iron gear makes them quite economical. You will remember we purchased some of your pinions about five months ago some of which are still in service. I have to-day sent you an order for four dozen."

Awarded the Highest Medals.—The Clark Electric Company, 192 Broadway, this city, has received a special medal for its automatic safety device from the American Institute Fair, which closed Saturday, Nov. 29. The judges of electrical apparatus visited the factory of the Clark Company and tested the safety device by cutting the electric wires and allowing them to fall on other wires, and in every instance the device proved its efficiency by removing all danger. The judges also awarded the Clark Electric Company a medal of superiority for its arc lamp for incandescent circuits. This lamp was beautifully mounted in an ornamental fixture and was much admired by the visitors at the fair. The company is introducing this style of fixture for interior lighting, for stores, theatres, public halls, etc. Mr. Clark, the electrician of the company, is an indefatigable worker, and seems to possess a faculty for inventing new and useful electrical apparatus.

Magnolia Metal.—Mr. H. Pann, inspector of engines for the Hamburg-American Steamship Company, has sent to the Magnolia Anti-Friction Metal Company the following excellent testimonial as to the value of magnolia metal: "In reply to your inquiry regarding my experience gained by using your magnolia anti-friction metal, I readily state to you that I have used it for longer than a year in many of the steamers belonging to this company, with the most satisfactory results. It has never cut, has never become warm or melted, and has invariably put a splendid surface on the journals. The lasting quality of the metal is very great, the saving of oil very considerable. The magnolia metal is particularly useful in relining worn-out brasses. I consider it to be the best of all anti-friction metals in the market, and shall continue to use it on our steamers. I can confidently recommend it to all steamship companies."

New Offices of the International Okonite Company.—The new factory of the International Okonite Company (Limited), at Passaic, N. J., being practically finished and in tip top running order, this enterprising and progressive concern has turned its attention to improving its New York headquarters, 13 Park row. By the acquisition of three or four more rooms in addition to those formerly occupied, the company has acquired every facility for the systematic and expeditious carrying on of its immense business. The new offices of the company, while richly artistic in all their fixtures, have an air of refinement and propriety in their elegance, which prevent any idea entering the visitor's mind of display in decoration solely for decoration sake. Everything is elegantly serviceable. As you step from the elevator at the fourth floor of the building, 13 Park Row, you are landed immediately in front of the entrance to the company's quarters. A door opened ushers you into a reception or waiting room. Here one makes known his business with the company before he can proceed further. This reception room is artistically and comfortably furnished. The private offices of Capt. Willard L. Candee, Mr. George T. Manson, Mr. H. Durant Cheever and sales agents' quarters are at the farther end of the reception room and on its left as you enter. The general sales agents, Mr. T. McCoubray and assistants, occupy an oblong room which forms a sort of hall between the private and general offices. They are replete with every facility for the convenience of those here located; desks, chairs and incandescent light; in fact the offices of the company are lighted throughout by electricity. To the left of this department and facing the busy thoroughfare, Park row, are the private offices of Capt. Candee, Mr. Manson and Mr. Cheever. They comprise most of the space occupied by the old quarters of the company. Artistic lettering on the glass panel of the door will tell you that Capt. Candee occupies the first room, Mr. Manson the second and Mr. Cheever the third. These rooms are well lighted, equipped with desks, chairs and cabinets of finely carved and highly polished oak. Communication from each of these offices is made to the department presided over by Messrs. Hodgkins, Brumley and Ashton by means of push buttons and speaking tubes. The financial or business part of the Okonite Company's office is located at the farther end of the reception room and on its right as one enters, a finely wrought oaken railing separating this department, of which Mr. Hodgkins is the head and leading spirit, from the rest of the office. Once past this gentleman's desk, which is situated at the entrance, you notice at once the admirable and comfortable arrangements made for the working force of clerks, book-keepers, stenographers, etc. There is a place for every one and everything. Communication between the several departments here represented and Mr. Hodgkins are made very complete by the aid of push buttons and speaking tubes. The International Okonite Company in its present quarters can safely lay claim to an office which, in point of convenience and elegance, cannot be surpassed by any of its size in the city, and such an office as a firm of its commercial importance fully deserves.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Work Shop Recipes.—1. Will you please give me a recipe for cementing and polishing hard rubber? 2. How can I give iron the beautiful black appearance often seen on magnet armatures and the like? ENGINEER.

1. Try marine glue. Polish as you would very hard wood. 2. Various makers use different sorts of blackening preparations. One that is well spoken of is produced by boiling turpentine and sulphur together and covering the iron with it. The evaporation of the turpentine leaves a thin layer of sulphur and on heating a short time over a gas or spirit flame this unites with the iron, forming a black coating. This particular preparation is highly spoken of, but requires rather careful manipulation.

Solid versus Hollow Conductors.—It is sometimes stated that electricity resides only on the surface of bodies. Under these circumstances is the carrying capacity of a conductor the same whether it is solid or hollow? P. A. G.

A static charge resides practically only on the surface of a charged body. A steady current, however, flows throughout the entire substance of a conductor. This is not the case, however, with a rapidly alternating current, and even with the frequencies of alternation used in everyday practice there is a greater current density near the surface of a conductor than in the centre, provided the wire is a very large one. With a very high frequency, copper in the interior would be of little or no service as a conductor. For all ordinary cases, however, either with constant currents and conductors of any size, or alternating currents with the wire generally used for them, the carrying capacity of a solid conductor and a hollow conductor of the same cross-section would be the same.

Edlund's Theory of Electricity.—I wish to investigate Edlund's theory of electricity, especially his theory of vacuum conduction, which I have found mentioned in the Smithsonian report for 1887. This refers to *Wiedermann's Annalen* and to the *Journal of Physics*, in either of which I might possibly find a full treatment of the subject. Where can I find these, or other and later information on the topic? J. G. G.

Edlund's theory of conduction in a vacuum is generally discredited by the scientific world, as it seems to rest on misapprehension of experiments. If, however, you desire to look it up, the best thing to do is to consult the files of the scientific periodicals during the past five years. *Wiedermann's Annalen* and the *Philosophical Magazine* are the best places for you to look, and your best way of getting the information is to go to the files and look them over. They can probably be found in one of the Chicago libraries, the library of the University of Michigan, and in numerous places if you chance to be in this part of the country, Columbia College library for example. A subject of this kind can only be properly investigated by thorough looking over of the literature, although for the reason which we stated at the beginning of this reply we do not think that you would do well to waste much time investigating a theory which rests on very doubtful foundations.

Electricity from Coal.—Having read the article in your paper entitled, "Edison on Electricity Direct from Coal," and also having read the same paragraphs in one of the Sunday papers, would you kindly permit me to ask you a question in regard to the above? The reporter who interviewed our great inventor states that if we could generate electricity direct from coal (taking into consideration that our pyroelectric machine is very efficient, say a loss of a few per cent. in conversions), we could drive our ocean greyhounds which now take thousands of tons of coal to accomplish their six-day run across the ever narrowing space of water, would only take but a few basketfuls of coal to propel our boats making double the speed, thereby decreasing our time to so short a period as three days. Is the above correct? We know that the efficiency of the best known steam engine converts 15 per cent. to 20 per cent. of coal power applied to it. That means, does it not, that 80 per cent. to 85 per cent. of the coal power is wasted or lost, or, in other words, we could drive our ocean steamers with just five to six times less coal and produce the same power as we derive from our steam engines of to-day. J. P. L.

The reporter who interviewed Edison, getting the information you refer to, overstated the matter considerably. If we could produce electricity direct from coal, converting the energy of chemical combination directly into current, we should have little or no loss instead of losing as at present at least 80 per cent. of the energy in operating a steam engine. This would mean, as you suggest that only one-fifth the quantity of coal would be required to produce a given amount of useful work. The baskets referred to would have to be very, very large ones. We are glad you called attention to the article, for while it certainly points a moral it is a gross exaggeration of possibilities.

Business Notice.

Battery Cut-out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

Intelligent people, who are familiar with the respective advantages which are offered by the several competing railroad lines between Chicago, St. Louis and Kansas City, and who desire to travel with the utmost speed, safety and comfort, always take the popular and reliable Chicago & Alton Railroad between these points, and passengers going to or coming from the South, via St. Louis, or when going to or coming from the West, via Kansas City, should insist upon having tickets that read over the Chicago & Alton. It is the only road with three complete and elegantly equipped trains daily between Chicago and each of the points named, and no railroad managers in America have a more intelligent appreciation of the wants of the traveling public than do those of the famous Chicago & Alton.

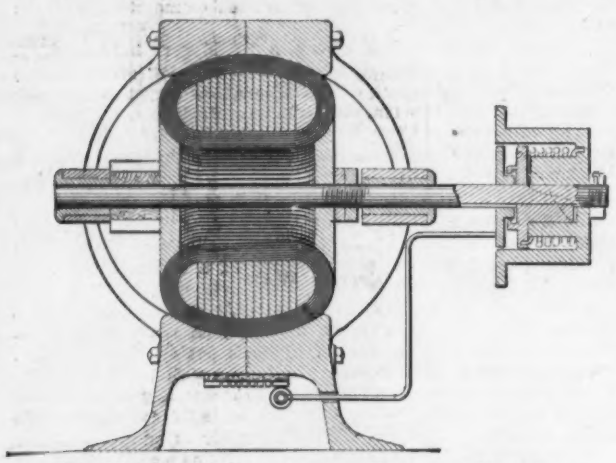
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED NOV. 25, 1890.

441,665. Regulators for Electric Motors; Walter E. Hyer, of Newburgh, N. Y. Application filed Oct. 10, 1889. The combination, with the driving-shaft of an electric motor, of a pulley loosely mounted on said shaft and having a cam, a block feathered on the shaft and having a cam engaging the pulley-cam, and a spring connecting the pulley and block and located inside the pulley.

441,695. Brush-Holder for Electric Motors or Dynamos; William S. Patterson, of Allegheny, Pa. Application filed Aug. 20, 1890. In a brush-holder for electric motors or dynamos, the combination, with a commutator, of a yoke tightly clamped around the bearing of the commutator shaft and provided at one end with an opening, a bolt fitted in the opening at the end of the yoke and insulated therefrom, a sliding frame adjustably secured to one end of the bolt, a brush fitted in said frame, and means, substantially as described, for normally forcing the brush in contact with the commutator.

441,703. Electric Signaling System; Joseph W. Riggs, of Minneapolis, Minn., Assignor to the Riggs Electric Traveling Danger Signal Co., of same place. Application filed Sept. 12, 1889.



No. 441,665.—Regulator for Electric Motors.

The combination, with the track rails and insulated conductor of a draw-bridge carrying contact devices and wires connecting the rails and conductor with such devices.

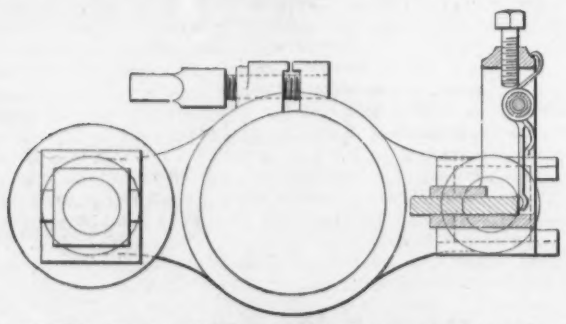
441,753. Trolley-Stand; William LeRoy Emmet, of East Rockaway, N. Y. Application filed Sept. 18, 1890. A trolley-pole pivoted at its lower end and attached in opposite directions to extensions on a pair of rocking levers, said rocking levers, and a battery of springs connected between other extensions on said rocking levers.

441,764. Trolley-Covering for Electric Railways; Hiram Jones, of Detroit, Mich. Application filed Sept. 13, 1890. The combination, in an electric railway, of an electrical-conducting rail located above the ties for the travel of a trolley-wheel, and a shield having imperforate top and side walls and supported over and continuously covering the rail, said side walls extending down past the rail at opposite sides thereof.

441,771. Gearing and Motor-Supporting Mechanism for Electric Locomotives; Frank Mansfield, of New York. Application filed April 8, 1890. An electric locomotive having the motor thereof supported entirely upon the car and attached thereto by swinging members.

441,773. Automatic Electric Railway Signal; Robert O. Owen, of Lynchburg, Va. Application filed March 18, 1890. The combination, with a main line circuit and a battery and signaling device, of a series of terminal contacts having independent connection with the main line, a series of twin or companion contacts, connected to ground, the pairs being spaced to represent the numbers of the stations, and a contact spring, wheel, plate or brush mounted upon the car and arranged to close contact between the plates to automatically transmit signals to the despatcher's office.

441,793. Dynamo-Electric Machine; Walter K. Freeman, of Brooklyn, N. Y., Assignor to William S. Hadaway, Jr., trustee, of Boston, Mass. Application filed Sept. 20, 1890. The combination, with the armature divided longitudinally into two parts, each



No. 441,695.—Brush Holder for Electric Motors or Dynamos.

having a complete peripheral flange and recesses or key-seats, of the bars or keys of insulating material in said seats, the annular plates of magnetizable material resting on said bars or keys between the flanges and the bolts or clamping devices.

441,794. Regulator for Dynamo-Electric Machines; Walter K. Freeman, of Brooklyn, N. Y., Assignor to William S. Hadaway, Jr., trustee, of Boston, Mass. Application filed Sept. 20, 1890. In a dynamo-electric machine, the combination, with the armature and field-magnets, of the pole pieces pivotally mounted on the ends of said magnets and having lugs or projections, eyebolts journaled in said lugs, and a right-and-left-hand screw-shaft co-operating with said eyebolts to vary the position of the pole pieces simultaneously with relation to the armature.

441,800. Trolley Wire Hanger or Support; Edward H. Kitfield, of Lynn, Assignor of two-thirds to Herbert C. Wirt and James L. Kimball, of Boston, Mass. Application filed March 12, 1890. In accordance with this invention the hanger or support is composed of two parts or members, one member, preferably the upper member, being provided with extensions or arms, and the other member being adapted to be fitted between the said arms, and provided with a longitudinal groove or recess to receive the trolley wire, the said central member being secured to the upper member so as to hold the trolley wire against the extended arms of the upper member.

441,807. Motor Regulator; David Pepper, Jr., of Philadelphia, Assignor to himself and Harry G. Clay, Jr., of same place. Application filed Oct. 1, 1890. The invention consists of a resistance box connected at one end with the circuit, a switch arranged by a progressive movement to complete the circuit through the resistance box, gradually cut out resistance, and finally cut the resistance box again out of the circuit, a second switch arranged to connect with the source of supply at the time the first switch completes its movement and severs connection with the resistance box, and automatic means for moving said second switch over the contact plates of a resistance box connected through it with the circuit

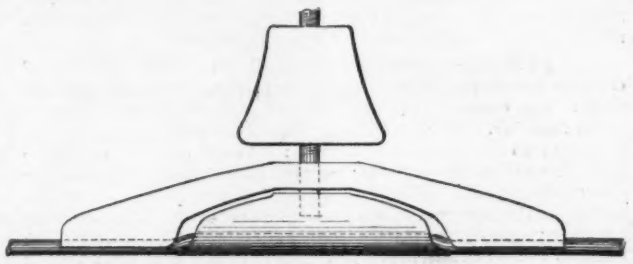
441,817. Electro-Thermostatic Valve; Louis Bell, and Frank H. Root, of Chicago, Ill. Application filed July 5, 1890. The combination with a fluid-controlling valve, of a volatile fluid chamber having a diaphraghm connected to the valve and adapted to operate the latter, and an electric circuit including a resistance for heating the volatile fluid, and a circuit closer.

441,818. Electrode for Secondary Batteries; Joseph Y. Bradbury and Frank J. Stone, of Lowell, Mass. Application filed Nov. 16, 1889. The invention consists in an electrode comprising a plate of supporting material having its opposite faces formed into alternate projections and depressions for the reception of active material, two opposite sides of each of said depressions being open and laterally adjacent projections opening into each other, and said plate being preferably formed of strips of supporting material arranged side by side, and each offset alternately in opposite directions for the reception of active material.

441,828. Electro-Magnetic Traction-Increasing System; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same place. Application filed Aug. 25, 1890. This invention consists in the combination, in an apparatus for electrically increasing the traction of a vehicle moving upon a railway, of a source of electricity, coils distributed at intervals along the railway, a circuit leading from the source of electricity and including the coils, stationary cores in the said coils having their poles connected to or in contact with the rails, and the wheels and axles of the vehicle.

441,837. Conduit for Electric Conductors; Edwin T. Greenfield, of New York, Assignor by mesne assignments to the Interior Conduit and Insulation Company. Application filed Dec. 14, 1889. The invention consists in combining with a body of insulating material in the form of a tube a thin skin of a material of lower inflammability than the insulating material, which skin for certain uses shall be of a conducting material.

44 ,838. Attaching Device for Electric Conductors; Edwin T. Greenfield, of New York, Assignor by mesne assignments to the Interior Conduit and Insulation Company. Application filed March 3, 1890. An attaching device for electrical con-



No. 441,800.—Trolley Wire Hanger.

ductors or conduits, comprising a flexible metal plate provided with a hole, tongue and eye stamped therein, said hole adapting the device to be attached to a wall or ceiling by a nail or screw and said tongue and eye serving as a lock.

441,840. Underground Conduit for Electric Wires; Edwin T. Greenfield, of New York, Assignor by mesne assignment to the Interior Conduit and Insulation Company. Application filed May 27, 1890. The combination of tubes forming wireways, a trough for said tubes having grooves in its opposite sides and holes in its bottom, and upright and cross pieces fitting, respectively in said grooves and holes, whereby said tubes are held separate.

441,843. Galvanic Battery; Albert H. Hoy, of Racine, Wis. Application filed May 26, 1890. In a dry battery, the combination with the receptacle, of the elements, and an exciting medium, of porous stoppers for said receptacle for securing the ventilation of the battery.

441,847. Telegraph-Circuit; Francis W. Jones, of New York. Application filed June 24, 1890. In a main or repeating telegraph station, the combination with a system of multiplex receiving and sending local circuits of a source of electric current, equalizing resistances, three-point switches, which are adapted to connect said local circuits either with a source of electric current or with the wedges, or their equivalents, which may be inserted in or connected with spring-jacks, forming part of the sending and receiving local circuits of another multiplex system.

441,849. Electric Line-Hook; Fred, M. Locke, of Victor, and John Lapp, of Rochester, Assignors of one-third to Theodore M. Norton, of Victor, N. Y. Application filed Sept. 8, 1890. A line-hook provided with a shank longitudinally reduced in size on one side and threaded around the balance.

441,877. Incandescent-Lamp Fixtures; Frederick Lewis, of New Haven, Conn., Assignor to John C. English, of same place. Application filed Aug. 9, 1890. This invention consists of a two-armed operating lever having its central portion or body adapted to fit over or embrace an ordinary flat key or thumb-piece.

441,892. Apparatus for Electroplating; William J. Possons, of Cleveland, O., Assignor to the Brush Electric Co., of same place. Application filed Oct. 18, 1889. A clamp for electroplating provided with contacts for opening and closing an electric circuit.

441,893. Apparatus for Electroplating; William J. Possons, of Cleveland, O. Application filed Oct. 21, 1889. The combination, with a plating tank having a vertically-adjustable trackway, of a truck mounted on the trackway and clamps suspended from bars supported by the truck.

441,894. Apparatus for Electroplating Carbons or other Materials; William J. Possons, of Cleveland, O., Assignor to the Brush Electric Co., of same place. Application filed Oct. 17, 1889. In an electroplating apparatus, a charging apparatus comprising a series of tubular holders.

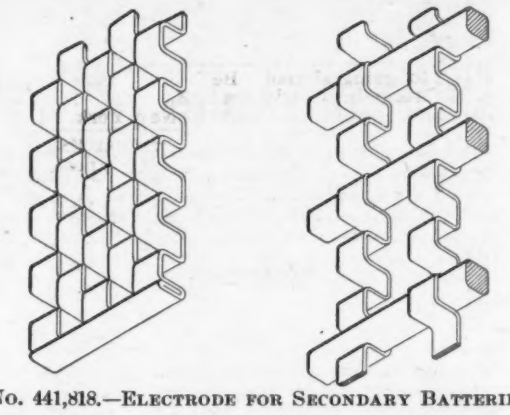
441,918. Rheostat; Timothy K. Ames, of Wilmington, Del., Assignor of one-half to James D. Carter, of same place. Application filed Sept. 15, 1890. The combination in a regulating switch of a spool and a resistance coil wound thereupon, one head of the spool carrying the resistance-terminals and the other head of the spool constituting the base or back plate whereby the switch is secured to a wall or other surface.

441,919. Electric Wire Coupling; William Edgard Banta, of Springfield, O. Application filed June 11, 1890. In a wire-coupling, the combination, with the joining end of line wires, of a plurality of rings embracing them, and each adapted to bite on to said wires as it assumes an oblique position under the suspension strains of the coupled wires.

441,933. Thermal Cut-out; David J. Cartwright, of Boston, Assignor to the Electrical Safety Company, of Portland, Me. Application filed April 26, 1890. In a fusible cut-out for electric circuits, the combination, with a fusible wire which is fused or broken in the passage through it of abnormally strong currents, of a series of plates of infusible and non-conducting material interposed between the terminals of the fusible wire, through or around which plates the fusible wire passes in a zigzag direction.

441,953. Electric Motor; Henry Groswith, of Philadelphia, Assignor, by direct and mesne assignments, to the Kennedy-Groswith Electric Company, of same place. Application filed Aug. 13, 1889. The combination, with the field magnets and armature of an electric motor, said armature having separate coils connected, respectively, to commutators having positive and negative brushes on opposite sides of the machine, of a reversing lever, a conductor connecting said lever with the positive pole of a source of electricity, contacts electrically connected with each of the positive brushes of the commutators, the field magnets having their terminal wires connected with said positive brushes, and the return conductor connected with the negative brushes of the commutators and with the negative pole of the source of electricity.

441,954. Method of Operating Electric Motors; Henry Groswith, of Philadelphia, Assignor, by direct and mesne assignments, to the Kennedy-Groswith Electric Company, of same place. Application filed March 5, 1890. In an electric motor, the combination of an armature core wound with two sets of coils, two commutators, brushes, a field-magnet having two sets of coils, one terminal of each set being connected to one brush of its



No. 441,818.—Electrode for Secondary Batteries.

respective commutator and to a common conductor, and the other terminal of each set of field-coils being connected to the other corresponding brush and to a contact or binding post for external connection.

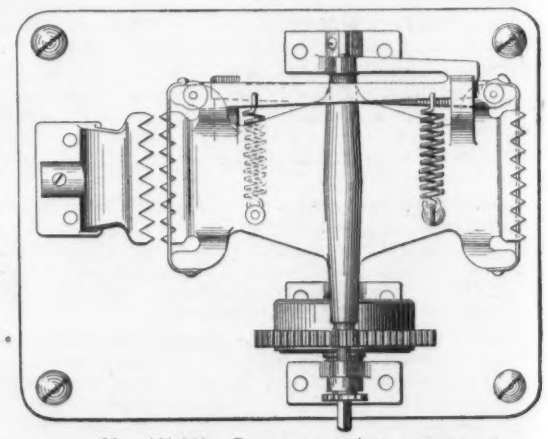
441,958. Secondary Battery; Charles W. Kennedy and Henry Groswith, of Philadelphia, Assignors to the Kennedy-Groswith Electric Company, of same place. Application filed April 7, 1890. A plate or grid for use in and as a component of the electrodes of a secondary or storage battery, consisting of a plate of lead or analogous material, having outwardly projecting knobs or projections integral with the plate, and arranged in rows or series alternately, with apertures having raised burrs or bosses surrounding them on the inner or smooth side of the plate.

441,959. Electrode for Secondary Batteries; Charles W. Kennedy, of Philadelphia, Assignor by direct and mesne assignments to the Kennedy-Groswith Electric Company, of same place. Application filed June 23, 1890. An electrode for electric batteries, consisting of two or more plates of rigid metal coated on both sides with metallic lead, said plates being connected together with an intervening space filled with active material, and provided with apertures for the passage of the exciting liquid.

441,967. Galvanic-Battery; Candido Grave De Peralta, of Havana, Cuba. Application filed May 23, 1890. In a galvanic battery, the combination of zinc and carbon electrodes separated by blocks of insulating material and bound together, a metallic containing vessel, and a paste containing an active and a deliquescent material surrounding the electrodes.

441,999. Lightning-Arrester; James J. Wood, of Brooklyn, N. Y. Application filed July 14, 1890. The combination, with the discharge plates of a lightning-arrester, of an arc-rupturing device and a thermic device arranged out of the path of the lightning discharge and in position to be heated by an arc between said plates, and adapted by its consequent expansion to set the arc rupturing device in operation.

442,002. Moving Contact for Electric Railways; Arthur Wellington Adams, of Kansas City, Assignor of one-half to



No. 441,999.—Lightning-Arrester.

Francis E. Nipher, of St. Louis, Mo. Application filed Dec. 23, 1889. The invention consists in the provisions of an "endless belt" or band mounted upon suitable pulleys and traveling upon the surface of the conductor, said endless belt or band being mounted as an "idler," moving solely by reason of its frictional contact with the conductor against which it is held with yielding pressure.

442,018. Electric Arc Lamp; Thomas P. C. Crampton, of London, England, Assignor of one-half to Albert Essinger, of same place. Application filed July 14, 1890. In an electric arc lamp, the combination, with a pair of differential solenoids and adjustable stops, of an upper carbon-holding tube, having at its upper end a tubular iron core sliding in the solenoids and provided at its lower end with spring clutch jaws acted on by the adjustable stops to release the carbon.

442,029. Annunciator; Frank E. Fisher, of Detroit, Mich. Application filed July 7, 1890. In combination with two electro-magnets and an armature adapted to vibrate between them and a pointer pivoted on said armature.

442,030. Electric Switch; Frank E. Fisher, of Detroit, Mich. Application filed July 7, 1890. An electric switch composed of the pivoted yoke carrying an insulating bar and contact plates, and spring and bell-crank lever pivotally connected with said yoke.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1836—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.